Technical Report
CMU/SEI-91-TR-14
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Carnegie-Mellon University
Software Engineering Institute

Proceedings of the CASE Adoption Workshop

Cliff Huff
Dennis Smith
Kim Stepien-Oakes
Ed Morris

May 1992

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Cliff Huff
Dennis Smith
Kim Stepien-Oakes
Ed Morris
Paul Zarrella

CASE Technology Project

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, Pennsylvania 15213

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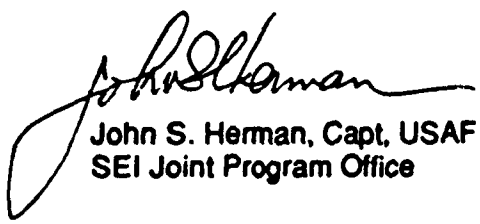
Review and Approval

This report has been reviewed and is approved for publication.

FOR THE COMMANDER



John S. Herman, Capt, USAF
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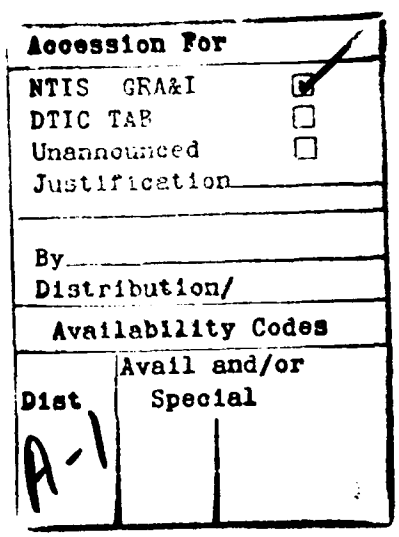

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Proceedings of the CASE Adoption Workshop

Abstract: The Software Engineering Institute (SEI) CASE Technology Project sponsored a workshop to address a number of key CASE adoption issues. The workshop was held at the SEI in Pittsburgh, Pennsylvania on November 13-14, 1990. At the workshop, a representative group of SEI affiliates from industry, government, and academia discussed among themselves such adoption topics as CASE benefits, realistic CASE budget estimates, CASE tool fit, CASE adoption roles, and factors in the project success of CASE. The results of these discussions are summarized in this report.

1 Introduction

The adoption of new technology into an organization is rarely a simple matter. This is true when adopting a new CASE (computer-aided software engineering) technology into a large organization. There are many factors that have an impact on the ultimate success or failure of a new CASE tool. Potential adopters should be aware of these factors, so they can consider what ramifications they might have in their organization and plan accordingly.

A CASE adoption workshop was held at the Software Engineering Institute on November 13-14, 1990, to collect, explore, and share the CASE adoption expertise and insight of the SEI affiliates. This workshop gathered 43 professionals from industry, government, and academia with a common interest in CASE and CASE adoption. It was sponsored by the CASE Technology Project at the Software Engineering Institute.

1.1 Keynote Address

As the introductory keynote address, Dr. Jonathan Morell of the Industrial Technology Institute spoke on "CASE Implementation: Dynamics Through the Technology Life Cycle." This address and the commentary that followed were based on the considerable experience that he and the Industrial Technology Institute have in transitioning many forms of high technology from research to commercial practice. Summarized below are his four keynote conclusions:

- CASE implementation can be planned, managed, and evaluated.
- Efforts to promote the use of CASE must be seen in terms of the entire technology life cycle.
- Strategies within that life cycle have varying time horizons for success and different requirements for collective and individual action.
- Within any single organization, CASE implementation hinges on a set of highly dependent interactions among HiTOP (High Integration of Technology, Organization, and People) elements.

For a complete hard copy of his companion paper on this topic, see Appendix E.

1.2 Workshop Session Overviews

There were five concurrent workshop sessions:

- Adoption Roles and the Adoption Life Cycle for CASE Tools.

  Identified the key roles, activities, and issues that must be addressed in a typical adoption life cycle for CASE. During the session these items were documented in a Life Cycle Matrix. The matrix suggested entry and exit criteria and actions to take for each adoption life-cycle phase, and issues to pay attention to for each of the appropriate roles in a particular adoption phase.

- Can You Get the Benefits of CASE Without Buying It?

  Determined which benefits (if any) could be derived from CASE technology, independent of the CASE tools themselves, i.e., benefits that result from the formal specification of a development project.

- The 'CASEability' of Projects.

  Examined what essential qualities of a software development project must exist to introduce CASE or, if already begun, to accelerate CASE adoption. In addition, the session tallied a list of recommended actions needed to create these essential project qualities.

- Developing a Realistic Estimate for CASE Tool Adoption.

  Developed a core cost estimation framework to aid others in preparing detailed CASE budgets. This CASE budget framework included guidelines for determining the amounts of people, time, and money needed for CASE tool adoption.

- Making the CASE Tool Fit the Organization and the Organization Fit the CASE Tool.

  Explored tool and organizational characteristics that facilitate or inhibit CASE tool adoption. Examined changes to tools and to organizations that improve the chances for successful adoption.

2 Executive Summary of CASE Adoption Workshop

This first CASE Workshop sponsored by the SEI yielded useful models and insights to aid SEI affiliates in their efforts to integrate CASE technology effectively into their organizations. In some cases the sessions had implications for additional work and future research. One such topic is the CASE estimation model, which aids in developing realistic CASE estimates. In addition, the session on the CASEability of projects raised a number of provocative issues for SEI consideration. Summary results from each of five CASE Adoption Workshop sessions are presented below.

2.1 Adoption Roles and the Adoption Life Cycle for CASE Tools

This session identified the key roles, activities, and issues that must be addressed in a typical adoption life cycle for CASE. These items were documented in a Life Cycle Matrix. The matrix illustrated entry and exit criteria for each adoption life-cycle phase, identified specific actions to take, and illuminated issues for each of the appropriate roles in a particular adoption phase. This matrix provides a good model for change agents to use when planning and executing a CASE adoption in their organizations.

The completed matrix is composed of 42 cells. The matrix contains 6 columns of roles and 7 rows of life-cycle phases. The 5 roles are:

- Upper Management
- Line Management
- Product Champions
- Change Agent
- Pilot Project Team
- Target Users

The 7 life-cycles phases are:

- Assess the Need
- Select Candidate Products
- Evaluate Candidate Products
- Present Product to Management, Users
- Gather User Information
- Plan the Implementation
- Implementation and Ongoing Support

2.2 Can You Get the Benefits of CASE Without Buying It?

This session addressed which benefits (if any) could be derived from CASE technology, independent of the CASE tools themselves.

In general terms, CASE technology can be thought of as "any computer-based assistance that reduces the labor intensity of project development." Participants in this session felt that the current orientation of CASE to software is at too low a level, and that what is really needed is Computer Aided Project Engineering (CAPE).

Participants determined that the primary benefit of CASE tools is in the enabling or automating of a defined methodology. A methodology is essentially a network of iterative work tasks. To benefit effectively from CASE technology, users would first have to define a methodology appropriate to their development process. But in automating a methodology, automation should not control the development process or methodology, but rather should work flexibly in support of the project.

Finally, as the emphasis of the session was on CASE without tool support, participants discussed several aspects of CASE that related specifically to adoption of the technology. The following conclusions were drawn:

- Many methodology decisions give inadequate regard to cost.
- Management underestimates the difficulty of change.
- Productivity is the result of a well-defined process.
- Process quality, not productivity, must be the focus of change.
- Product quality will result from process quality.
- Tools will evolve in support of a viable defined methodology.

2.3 The 'CASEability' of Projects

This session examined what essential attributes of a software development project must exist to introduce CASE or, if already begun, to accelerate CASE adoption. It uncovered no "silver bullets," but it did identify a number of key areas in which more work is required.

This session identified 76 attributes of a software development project for consideration. These attributes were organized into 7 different classifications. Of the 76 attributes identified, 13 top attributes were highlighted as most relevant to the potential success of using CASE on a particular project. Of these, it was noted that preconditions and management factors far outweighed technical and tool issues.

This session also developed a list of 13 recommendations which, when implemented, would do the most to ensure the success of using CASE on a particular project. An abbreviated version of these recommendations is listed below:

- Develop a plan for CASE adoption.
- Create a metrics program.
- Establish a dedicated process, methods, and tools group.
- Establish a management mandate for automated process, methods, and tools.
- Select CASE tools that are extensible.
- Modify MIL STD DIDS to focus on methods and plans for CASE utilization.
- Designate a CASE adoption leader with a mandate for action.
- Establish or join CASE adoption societies.
- Identify incentives and rewards for CASE adoption.
- Create a CASE adoption risk reduction program.
- Establish a plan for up-front and continued training and incentives for CASE tools.
- Provide adequate schedule flexibility for CASE adoption.
- Establish a lessons-learned CASE tools usage database.

2.4 Developing a Realistic Estimate for CASE Tool Adoption

The aim for this session was the development of a core cost estimation framework to aid others in preparing detailed CASE budgets. This CASE budget framework is aimed at developing guidelines for determining the appropriate amounts of people, time, and money needed for CASE tool adoption.

There were three main products from this session:

- A list of 51 CASE economic issues
- Two summary tables:
  - CASE Adoption Life-Cycle Estimate Matrix
  - CASE Adoption Principle Cost Estimate Matrix
- An action plan for further investigation and refinement of this preliminary CASE Adoption Economic Model

These 51 CASE economic issues were divided into 6 categories:

- Process
- Management
- Economics
- Technical

- Standards
- Implementation

The two summary tables, the CASE Adoption Life Cycle Estimate Matrix and CASE Adoption Principle Cost Estimate Matrix, provide a quick overview of the major economic factors pertinent to CASE adoption. In addition, they attempt to highlight those elements that are primary cost drivers. Overall, these tables are designed to encourage potential planners to consider a wide range of factors that can influence the total cost of CASE adoption.

To achieve all of the session's original mission objectives, further effort coordinated by the SEI to complete the design of the CASE cost model is necessary. When completed, this CASE cost model would consist of a set of estimation algorithms, structured like the COCOMO software cost estimate model, and a guide book in its use.

For those seeking detailed information about specific tools and vendors, a set of CASE resource pointers was assembled.

2.5 Making the CASE Tool Fit the Organization and the Organization Fit the CASE Tool

This session examined changes that improve the chances for successful CASE tool adoption. Characteristics of tools and organizations that facilitate or inhibit CASE adoption were examined. Each characteristic was discussed in terms of the following factors (as applicable):

- Definition
- Examples
- How to implement
- Risks

Listed below is a summary of the four characteristics within each category:

1. Tool characteristics that facilitate CASE adoption
   - Customizable
   - Integratable
   - Vendor support
   - Extensibility
   - Documentation
   - Platform independence
2. Tool characteristics that inhibit CASE adoption
   - Failure to adopt industry trends
   - Poor performance
   - Tool proprietary methodologies

- Single-user versus multi-user tools

3. Organizational characteristics that facilitate CASE adoption
   - Defined/understood processes and standards
   - Training
   - Communication
   - Management support for implementation
   - Ongoing support
4. Organizational characteristics that inhibit CASE adoption
   - Cost
   - Maintenance versus new development
   - Heterogeneous development environment

3 Adoption Life Cycle and Roles

3.1 Theme Description

The purpose of the Adoption Life Cycle and Roles session was to identify the key roles, activities, and issues that must be addressed in a typical adoption life cycle for CASE.

3.2 Goal

The goal of this workshop session was to complete a matrix illustrating suggested entry and exit criteria and action to take for each adoption life-cycle phase, and issues to pay attention to for each of the appropriate roles in a particular adoption phase. This matrix is not definitive, but should provide a good model for change agents to use when planning and executing a CASE adoption in their organizations.

3.3 Process

Starting with a practical adoption model suggested by Barbara Bouldin [4], we examined the actions in each life-cycle phase that foster adoption. We also considered the issues and constraints that typically arise. Finally, we developed a prototype set of entry and exit criteria for each phase. We looked at the roles that are key to success in each adoption phase, and at the impact of each role on the overall success of adoption. We documented all this information in the form of a matrix, with the roles on the horizontal axis, the life-cycle phases along the vertical axis, and each cell containing entry and exit criteria as well as actions and issues. (See Table 1 for a view of the empty matrix)

To limit the scope of our work and focus our session, we assumed that we were:

- Working to describe the adoption of a CASE tool that addressed software design.
- Describing the adoption of the design method embedded in the tool.
- Dealing with a cohesive organizational unit, no larger than about 200 people, having multiple projects, and reporting to one manager.
- Dealing with a manager who had control over resources and could make a decision that this organization would or would not adopt the CASE tool.
- Viewing the adoption process from inside the adopting organization.

We were asking, in effect, what actions by members of that organization were needed to expedite the adoption. These actions need to be considered in the context of an organization. Smaller organization units would keep the roles described here, but scale down the effort accordingly. Smaller organization units would keep the roles described, but scale down the effort.

CASE Adoption: Roles and Life Cycle

Life-Cycle Phases		*Roles/Players*				
	Upper Mgt.	Line Mgt.	Product Champion	Change Agent	Pilot Project Team	Target Users
Assess the Need	Entry Crit. Actions Issues Exit Crit.					
Select Candidate Products	Entry Crit. Actions Issues Exit Crit.					
Evaluate Candidate Products	Entry Crit. Actions Issues Exit Crit.					
Present Product to Mgt., Users	Entry Crit. Actions Issues Exit Crit.					
Gather User Information	Entry Crit. Actions Issues Exit Crit.					
Plan the Implementation	Entry Crit. Actions Issues Exit Crit.					
Implementation and Ongoing Support	Entry Crit. Actions Issues Exit Crit.					

Adapted from B. Bouldin, *Agents of Change*, Yourdon Press, 1989

Table 1 CASE Adoption: Roles and Life Cycle

The approach to the session chosen by the session's facilitators, John Maher and Priscilla Fowler, provided an efficient structure for participants to pool their collective experience. Bouldin's adoption life cycle is representative of a number of life cycles that appear in the technology transition literature (see, for example, [25] and [6]). It was selected for three reasons: first, it exists in published form; second, it was derived from an industrial setting where CASE tools

were being adopted; and third, beginning with an existing and representative model allowed participants to focus on the actual steps needed by players in the adoption process. It was assumed that a session participant or anyone reading this material subsequently would need to tailor it, especially its terminology, to suit local environments and customs. At the beginning of the session, the approach was reviewed with participants and agreed to with slight modifications.

John Maher began the session with a brief tutorial, "Transitioning New Technologies," to introduce some concepts that would be needed to understand and fill the matrix. Most importantly, he defined the terms used in the horizontal axis of the matrix: upper management and line management (sponsors), product champion, change agent, pilot project team, and individual users (targets). At the upper management level, the sponsor provides resources, strategic and policy direction, and final approval to proceed with the adoption of CASE. At the line management level, the sponsor may authorize resources and direct efforts toward planning for CASE adoption and experimental use. The product champion is the individual who initially introduces the idea of a particular CASE tool or type of tool, and informally advocates it, calling it to the attention of others. The change agent is an individual or team, drawn from line management or software personnel, who does the detailed planning and implementation of the CASE adoption. The pilot project team tries the CASE tool for the first time on behalf of the larger organizational unit. The target users are the remainder of the organization who will eventually adopt the CASE tool. "Adoption" is defined as routine, everyday use of a CASE tool or technology. More background on these definitions can be taken from the details of the matrix itself.

3.4 Adoption Life-Cycle Phases

During the session, definitions of the adoption life-cycle phases, initially adapted from Bouldin, evolved:

1. **Assess the Need.** The champion considers how a CASE technology might improve the manner in which the organization develops software and collates information about what CASE tools might address the problems the organization faces.
2. **Select Candidate Products.** A quick survey of likely CASE products is made and candidates are selected which meet the organization's requirements.
3. **Evaluate Candidate Products.** One or two CASE products are tested by users working in projects typical of the organization. The best product is selected as a candidate for broader use within the organization.
4. **Present Product to Management, Users.** The product chosen is presented to management and potential users, with information on its costs, benefits, application, and projected results.

5. **Gather User Information.** Details on the broader target-user community are gathered as input to planning the implementation across the entire organization.

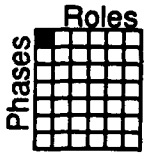
6. **Plan the Implementation.** Detailed plans are prepared.

7. **Implementation and Ongoing Support.** The selected CASE tool is installed in projects across the organization and support services are organized and delivered.

3.5 Matrix of CASE Adoption Roles and Life Cycle

This section is organized by horizontal rows in the CASE adoption matrix that was developed. Within each row, information is grouped by roles. The entry under each role within a row represents one cell of the matrix. There are 7 rows (life-cycle phases) and 6 columns (roles), for a total of 42 cells. Not all cells are populated—in cases that don't make sense, cells are left blank. Each cell is identified in two ways. First, the cell intersection is titled by *Role* (*Life-Cycle Phase*). Second, there is a *table icon* next to each title. This icon highlights the relative position of that cell in the overall table. Each cell contains Entry Criteria (when and why this step is taken), Action(s) taken, Issues, and Exit Criteria (when each step is completed and how you know).

3.5.1 Assess the Need



3.5.1.1 Upper Management (Assess the Need)

Entry Criteria

- Upper management generally favors quality, productivity
- Business condition exists that gets attention
- Upper management may be ignorant of opportunities
- Organization has a strategic plan
- CASE may be required in statement of work (SOW)
- Turnover in upper management leads to new executive with agenda

Actions

- Upper management may initiate a look into problems, opportunities (e.g., create a task force)

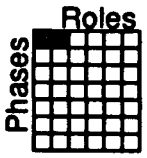
- Upper management may seek outside sources of education

Issues

- Influence of external business environment to move organization in a particular direction
- Direct cost on program and schedule
- How much the business of the organization will depend on software
- Improvement and quality
- Available work force
- Increasing complexity of software

Exit Criteria

- Report of task force, if any
- Decision to look at or abandon candidate technologies



3.5.1.2 Line Management (Assess the Need)

Entry Criteria

- Low productivity
- Over budget
- Not enough people to handle change requirements
- Management support of concept of productivity, quality
- Directive from upper management
- Exposure to new technology

Actions

- Authorize basic information gathering and/or education (conferences, literature, etc.)
- Interpret and support upper management decisions
- Influence and be influenced by upper management
- Provide guidance for next stage activities

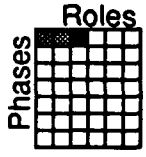
- Gather information from peers, within own group

Issues

- Driven by cost, schedule, people
- Turnover of personnel, with influx of new people
- Low morale

Exit Criteria

- Decision to accept, argue with or reject recommendation to proceed
- Commitment of people to work on the next stage



3.5.1.3 Product Champion (Assess the Need)

Entry Criteria

- Perception of need
- Willingness to ırsue issue
- Dissatisfaction with current state of affairs
- Ability to envision future state
- Knowledge of organization
- Ability to communicate vision, need
- Respect from organization members

Actions

- Test management's awareness of issues
- Begin "awareness building" activities (influence peers, influence planning process, arrange demos, give talks)
- Begin building business case for CASE
- Gather and test users' awareness of issues and need

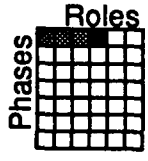
Issues

- Job security
- Management attitude, inertia
- Corporate policy, culture
- Politics

- Opportunities for information sharing
- Stability or degree of entrenchment of current system

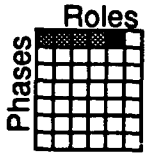
Exit Criteria

- Management convinced of need to look at candidate tools and methods
- Change agent appointed

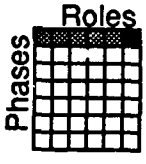


3.5.1.4 Change Agent (Assess the Need)

See Product Champion



3.5.1.5 Pilot Project Team (Assess the Need)



3.5.1.6 Target Users (Assess the Need)

Entry Criteria

- Champion or management contact

Actions

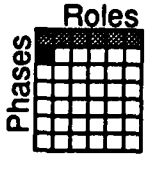
- Provide input to champion and/or management on work issues, needs, potential solutions

Issues

- Parochial views of problems

Exit Criteria

3.5.2 Select Candidate Products



3.5.2.1 Upper Management (Select Candidate Products)

Entry Criteria

- Commitment to look at candidate products

- Commitment to make a selection

Actions

- Authorize funds, resources, responsibility
- Set a time frame
- Tell line management to determine requirements and recommend alternatives

Issues

- Relationships with potential vendors
- Consistency with corporate goals, strategies

Exit Criteria

- Management report on requirements and alternative products to meet the need

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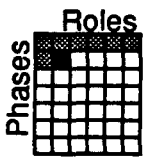


3.5.2.2 Line Management (Select Candidate Products)

Entry Criteria

- Directive from upper management or individual initiative to look at alternative tools and/or methods
- Identification of funding source

Actions

- Authorize and/or direct requirements analysis
- Authorize selection of candidate products (methodology before tool)
- Select and assign individual or team to selection task
- Communicate formal role of individual or team to organization
- Oversee and monitor selection process
- Allocate funds for selection process
- Direct creation of plan for selection

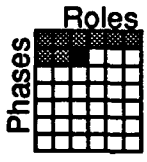
Issues

- Relationships with potential vendors
- Constraints of existing purchasing practices
- Constraints of security requirements

- Methodology and tool fit between process and organization
- Education of line management
- Schedule slippage with current projects due to reallocation of resources to selection task

Exit Criteria

- Report on candidate products received
- Methodology selected
- Decision made to proceed



3.5.2.3 Product Champion (Select Candidate Products)

Entry Criteria

- Continuing interest, dissatisfaction with current state

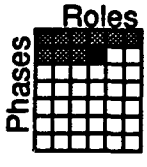
Actions

- Influence, lobby for method and tool among management, peers
- Provide expertise on method, tool

Issues

- Champion and change agent conflict on goals, procedures, etc.
- Champion's support of organization decision
- Impact of champion work on regular job

Exit Criteria



3.5.2.4 Change Agent (Select Candidate Products)

Entry Criteria

- Assignment to develop plan for selection

Actions

- Documents the adoption life-cycle process (lessons learned)
- Develops plan for selection
- Works with team to recommend tool and method, executes plan,

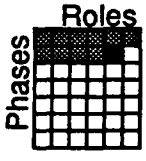
prepares report

Issues

- Adequacy of resources, time
- How legitimacy of role is conveyed to organization
- Competence of agent in methods and tools
- Competence of agent as change agent
- Rewards and risk for agent role
- How to deal with reluctant agent

Exit Criteria

- Methodology, tools selected for evaluation
- Report prepared and delivered to management



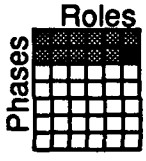
3.5.2.5 Pilot Project Team (Select Candidate Products)

Entry Criteria

Actions

Issues

Exit Criteria



3.5.2.6 Target Users (Select Candidate Products)

Entry Criteria

- Announcement of candidate selection process
- Announcement of change agent

Actions

- Respond to "idea" of innovation
- Provide input to selection plan
- Attempt to influence selection of pilot project, methods, tools

Issues

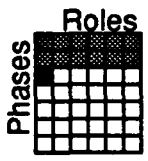
- Impact on users' projects, schedules

- Learning curve (contact, awareness, understanding)
- Unclear goals, information (affects expectations)
- Acceptance of change agent

Exit Criteria

- Input provided to management, agent
- Announcement of candidate products to evaluate

3.5.3 Evaluate Candidate Products



3.5.3.1 Upper Management (Evaluate Candidate Products)

Entry Criteria

- List of candidate methods, tools to evaluate
- Commitment to evaluate

Actions

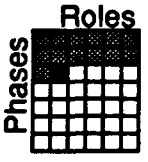
- Authorize resources for evaluation
- Communicate commitment to strategic goals
- Provide ongoing support and guidance from business perspective
- Make decision on recommended product

Issues

- Impatience with process
- Tendency to meddle with technical issues

Exit Criteria

- Decision communicated to organization on recommended product



3.5.3.2 Line Management (Evaluate Candidate Products)

Entry Criteria

Actions

- Commit resources to evaluation task (people, $$, time)

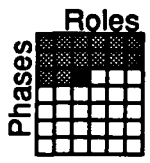
- Support preparation of business case
- Select pilot projects
- Deflect outside pressure on evaluation team
- Facilitate procurement of product
- Approve plan for pilot testing
- Monitor progress of evaluation
- Manage expectations (up, across, and down)
- Recommend product to implement
- Foster consensus among all those at risk

Issues

- Risk associated with trial use of new product
- Persistence of management in providing support
- Estimates (time, money, etc.) that are too small for task
- Risk of poor decision due to incomplete data

Exit Criteria

- Business case completed and product recommended



3.5.3.3 Product Champion (Evaluate Candidate Products)

Entry Criteria

Action

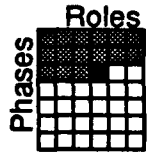
- Provide expertise on methodology, tool
- Influence selection of pilot project

Issues

- Conflict with change agent on goals, procedures, etc.
- Will champion support organization decision?
- Impact of championship on regular job

- Influence on pilot execution

Exit Criteria



3.5.3.4 Change Agent (Evaluate Candidate Products)

Entry Criteria

Actions

- Document the adoption life-cycle process
- Develop criteria and metrics for pilot selection, product evaluation, trial evaluation
- Recommend pilot projects
- Facilitate team development (evaluation team, pilot project teams, etc.)
- Develop plan for pilots
- Develop contract with tool vendors
- Procure products to evaluate
- Facilitate training of pilot teams
- Document software engineering process
- Monitor pilot execution and measure effectiveness
- Evaluate trial results
- Decide which tool and method to recommend
- Build business case with support from management
- Report to line management on progress
- Monitor budget and schedule of trial projects
- Manage pilot effort
- Conduct external evaluation of vendor, tool

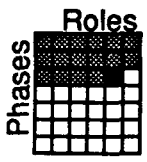
Issues

- Management of risk during pilot implementation
- Management of expectations in management, pilot teams, vendors
- Management of interface with everyone else
- Risk of partiality

- Potential lack of change agent and managerial skills
- Inability of pilot team to carry through test and meet production schedule
- Lack of authority to make decisions for pilot effort
- Inadequate access to line management, resources
- How best to develop metrics for trial results
- How to compare results across pilot teams

Exit Criteria

- Recommended tool(s) and method(s) identified
- Business case built and delivered to management



3.5.3.5 Pilot Project Team (Evaluate Candidate Products)

Entry Criteria

Actions

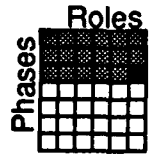
- Participate in developing pilot plan
- Be trained in use of method and tool
- Execute pilot project according to pilot plan
- Collect metrics during pilot testing
- Provide feedback on method and tool use

Issues

- Conflict between schedule and task assignment (pilot and other jobs)
- Separation of project tasks from product evaluation tasks
- Consistency of application across team of the tools or methods

- Rewards and risks for pilot implementation

Exit Criteria



3.5.3.6 Target Users (Evaluate Candidate Products)

Entry Criteria

Actions

- Respond to "idea" of innovation
- Attempt to influence selection of pilot project, methods, tools, metrics

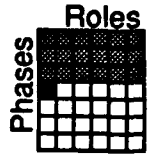
Issues

- Impact on users' projects, schedules
- Learning curve (contact, awareness, understanding)
- Unclear goals, information (affects expectations)
- Acceptance of change agent
- Acceptance of pilot project as "typical" of their work

Exit Criteria

- Input provided to management, agent
- Pilot results/decision known

3.5.4 Present Product to Management, Users



3.5.4.1 Upper Management (Present Product to Management, Users)

Entry Criteria

Actions

- Commit time, staff, money
- Identify target organizations for implementation
- Make public commitment to information gathering, presentation of method and tool

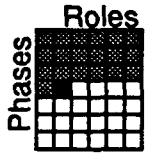
- Handle interface with higher management

Issues

- Potential for lack of understanding
- Potential for diminishing interest in effort
- Potential for "cold feet" due to cost, risk

Exit Criteria

- Decision to go ahead with implementation



3.5.4.2 Line Management (Present Product to Management, Users)

Entry Criteria

Actions

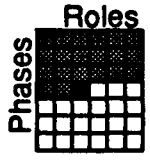
- Allocate time, staff, $$
- Identify target projects for implementation
- Make public commitment to information gathering, presentation of method and tool
- Handle interface with superiors, peers, subordinates

Issues

- Potential for lack of understanding
- Potential for diminishing interest in effort
- Potential for "cold feet" due to cost, risk
- Support from upper management

Exit Criteria

- Recommend decision to implement



3.5.4.3 Product Champion (Present Product to Management, Users)

Entry Criteria

Actions

- "Sell" the method and tool to users, management

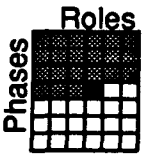
- Take part in demos

Issues

- Satisfaction with pilot results, recommendation
- Champion and change agent conflict on goals, procedures, etc.
- Support of organization decision
- Impact of championship on regular job
- Potential for defeated champions to resist decision

Exit Criteria

- Satisfaction with outcome (continues as champion)
- Dissatisfaction with outcome (because no longer a player)
- Presentations to management, users (if participant)



3.5.4.4 Change Agent (Present Product to Management, Users)

Entry Criteria

Actions

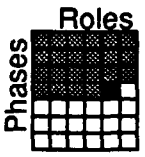
- Document the adoption life-cycle process (lessons learned)
- Undertake marketing, sales campaign
- Collect feedback, make notes for implementation planning
- Follow up with management for open action items
- Seek sponsorship

Issues

- Inexperience in marketing, sales
- Lack of confidence in method and tool decision

Exit Criteria

- Presentations to management, users completed
- Management decision on implementation



3.5.4.5 Pilot Project Team (Present Product to Management, Users)

Entry Criteria

Actions

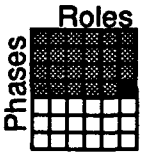
- Supports marketing effort
- Provides demos
- Influences target users

Issues

- Acceptance of method/tool
- Major dissension in project

Exit Criteria

- Demos and presentations completed (as requested)



3.5.4.6 Target Users (Present Product to Management, Users)

Entry Criteria

Actions

- Attend presentations/demos
- Voice concerns, issues, support (as appropriate)

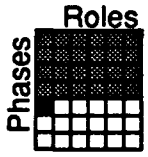
Issues

- Parochial view of work, method and tool, etc.
- Split in support by user community
- Indifference to innovation
- Perception that method/tool doesn't fit need
- Low morale
- Unsystematic implementation

Exit Criteria

- Presentations/demos done
- User input voiced

3.5.5 Gather User Information



3.5.5.1 Upper Management (Gather User Information)

Entry Criteria

Actions

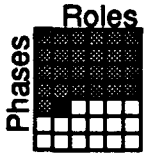
- Authorize activity to gather information
- Voice expectations about timetables, results
- Address questions as necessary
- Authorize preparation of implementation plan

Issues

- Exaggerated expectations of near-term results
- Support may not be unanimous

Exit Criteria

- Implementation plan preparation authorized



3.5.5.2 Line Management (Gather User Information)

Entry Criteria

Actions

- Identify key people for implementation planning
- Initiate and monitor activity to gather information
- Voice expectations about timetables, results
- Address questions as necessary
- Communicate information-gathering effort
- Gather and maintain support of peers
- Maintain an atmosphere for open dialogue

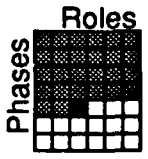
Issues

- Exaggerated expectations of near-term results

- Support may not be unanimous

Exit Criteria

- Information reported to management
- Planning team identified and assigned to work with agent



3.5.5.3 Product Champion (Gather User Information)

Entry Criteria

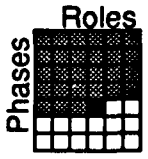
Actions

- Provides information
- Clarifies how method and tool can be used

Issues

- Biased
- May oversell
- May interfere with orderly data gathering process

Exit Criteria



3.5.5.4 Change Agent (Gather User Information)

Entry Criteria

Actions

- Document the adoption life-cycle process
- Prepare plan, instruments for gathering data
- Identify key data sources
- Gather data
- Facilitate worker-level consensus
- Raise issues with management

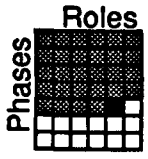
Issues

- Covert resistance/dishonesty of users
- Lack of experience in gathering data systematically

- Attempts to sabotage process
- Confidentiality of data, attribution
- Credibility of agent, sources

Exit Criteria

- Data gathered and ready for factoring into planning
- Data reviewed with planning team



3.5.5.5 Pilot Project Team (Gather User Information)

Entry Criteria

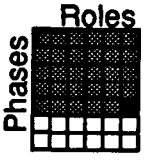
Actions

- Support change agent
- Provide conduit of information to and from users

Issues

- Inaccurate representation of users
- Credibility (if pilot not initially successful)

Exit Criteria



3.5.5.6 Target Users (Gather User Information)

Entry Criteria

Actions

- Provide information, concerns, perspective to agent
- Move toward consensus by looking at differences, similarities in user group
- Participate actively in data gathering effort
- Keep an open mind

Issues

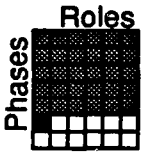
- Parochial view of effort

- Polarization of user group

Exit Criteria

- Interviews, etc., completed

3.5.6 Plan the Implementation



3.5.6.1 Upper Management (Plan the Implementation)

Entry Criteria

Actions

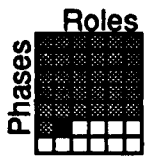
- Determine sources of funding
- Authorize funding, resources, etc.
- Approve or reject implementation plan
- Convey ongoing support of effort
- Maintain external interfaces

Issues

- Cost of implementation
- Funding sources
- Impact on ongoing projects, resources
- Link with strategic goals
- Legal ramifications

Exit Criteria

- Implementation decision made
- Funds for implementation authorized
- Sources for funding determined



3.5.6.2 Line Management (Plan the Implementation)

Entry Criteria

Actions

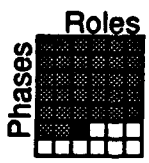
- Direct and monitor plan development
- Recommend plan to upper management
- Provide support, time for planning
- Convey impact of decision to organization
- Monitor staff morale
- Convey public support for effort
- Facilitate consensus among peers, subordinates
- Maintain an atmosphere for open dialogue

Issues

- Impact of planning, implementation on ongoing projects
- Impact on organization morale
- Maintenance of open atmosphere for discussion

Exit Criteria

- Plan to recommend to upper management
- Sense of level of support in organization



3.5.6.3 Product Champion (Plan the Implementation)

Entry Criteria

Actions

- Provides information for planning
- Provides input on training issues

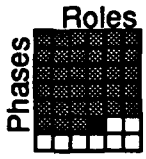
Issues

- Biased
- May oversell
- May underestimate training needs

- May interfere with orderly planning process

Exit Criteria

- Input to plan completed



3.5.6.4 Change Agent (Plan the Implementation)

Entry Criteria

- Assignment to develop plan

Actions

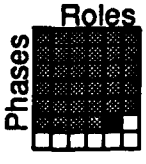
- Document the adoption life-cycle process
- Organize and build planning team
- Lead development of plan addressing organization-wide issues/implementation
- Chair the planning team
- Monitor morale, progress in team, users
- Maintain sponsorship
- Develop contingency plans

Issues

- Competence of change team
- Workload for change team
- Time management
- Shifting priorities
- Adequate information or access to information

Exit Criteria

- Plan submitted, revised, and accepted



3.5.6.5 Pilot Project Team (Plan the Implementation)

Entry Criteria

Actions

- Support planning team

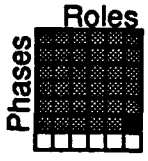
- Provide conduit of information to and from users
- Provide input for plan
- Review plan

Issues

- May not typify the user population

Exit Criteria

- Plan reviewed



3.5.6.6 Target Users (Plan the Implementation)

Entry Criteria

Actions

- Provide information, concerns, perspective to planning team
- Review plan (sample of users): work estimation, timing, support, rewards for implementation, learning curve, etc.
- Begin to rework existing schedules, if necessary

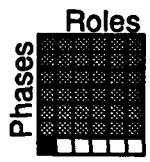
Issues

- Parochial view of effort
- Polarization of user group
- Impact of implementation on current projects
- Confidentiality of feedback
- Rewards for implementation

Exit Criteria

- Plan reviewed by sample of population
- In-progress rework scheduled, as required

3.5.7 Implementation and Ongoing Support



3.5.7.1 Upper Management (Implementation and Ongoing Support)

Entry Criteria

Actions

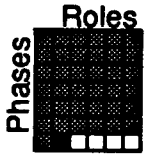
- Convey continuing support/sponsorship
- Link implementation success with reward system
- Initiate policy changes, updates
- Authorize funding, resource allocation updates as necessary
- Manage external interface
- Actively participate in communication, symbolic leadership, etc., in support of effort
- Monitor impact of implementation and ongoing activity
- Reward, recognize, & publicize success

Issues

- Level of continuing sponsorship
- Implementation problems, e.g., cost overruns
- Other pressing issues

Exit Criteria

- Implementation complete: method and tool routine part of business



3.5.7.2 Line Management (Implementation and Ongoing Support)

Entry Criteria

Actions

- Implement plan
- Monitor progress, results
- Facilitate surfacing and resolution of issues
- Facilitate establishment of ongoing implementation/support

activities (e.g., vendor support)

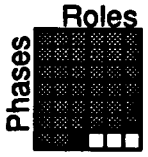
- Develop or direct development of policies that support method and tool
- Ensure that people use the product correctly
- Provide ongoing sponsorship
- Manage interfaces: peer, superior, subordinate
- Reward and publicize success, celebrate
- Allocate and adjust resources during implementation
- Adjust plan as necessary

Issues

- Meeting product delivery dates
- Managing resistance; maintaining morale
- Providing resources for support (training, consultation, equipment, etc.)
- Managing changes in management, strategic direction
- Reacting to staff turnover, reorganization

Exit Criteria

- Implementation complete: method and tool routine part of business



3.5.7.3 Product Champion (Implementation and Ongoing Support)

Entry Criteria

Actions

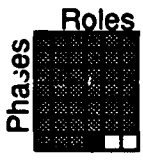
- Continue to provide support for effort
- Celebrate success

Issues

- Re-entry into normal work

Exit Criteria

- Implementation complete: method and tool routine part of business



3.5.7.4 Change Agent (Implementation and Ongoing Support)

Entry Criteria

Actions

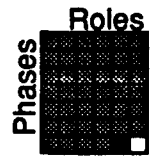
- Document the adoption life-cycle process
- Implement plan (see notes)
- Monitor progress
- Shift direction as necessary: negotiate altering plan
- Communicate sponsor support
- Provide feedback to sponsors, vendors
- Manage resistance
- Facilitate development of formal processes and procedures (e.g., custom user guide, draft organization policy, etc.)
- Facilitate establishment of ongoing implementation and support activities (e.g., vendor support, user group)
- Monitor status of vendor in marketplace
- Monitor developments in tool marketplace

Issues

- Change in strategic direction
- Change in organization, personnel, management
- Change in job
- Succession planning
- Impact of new technology

Exit Criteria

- Implementation complete: method and tool routine part of business



3.5.7.5 Pilot Project Team (Implementation and Ongoing Support)

Entry Criteria

Actions

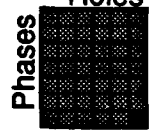
- May "seed" other projects with expertise
- May train other projects
- Provide information for user guide

Issues

- Version changes that make experience obsolete

Exit Criteria

- Implementation complete: method and tool routine part of business



3.5.7.6 Target Users (Implementation and Ongoing Support)

Entry Criteria

Actions

- Get training
- Use method/tool
- Address concerns, issues, problems in use
- Suggest solutions to issues, problems, etc.
- Provide informal training to peers
- Participate in user groups

Issues

- Quality, extent of support
- Learning curve
- Rewards for implementation
- Turnover
- Impact on daily work habits
- Impact on schedule, budget, etc.

- *Communication with superiors, agent*

Exit Criteria

- Implementation complete: method and tool routine part of business

4 Can You Get the Benefits of CASE Without Buying It?

4.1 Theme Description

The purpose of this workshop session was to determine which benefits (if any) could be derived from the formal specification of a development project using CASE technology, independent of the CASE tools themselves.

4.2 Goal

The output of this workshop session was a set of positions formalized by the participants about questions that were discussed, such as:

- What is CASE?
- What must be automated?
- What cannot be automated?
- What work tasks does CASE change?
- How can "not buying but using" be sold to management?
- What lessons can be learned from workshop participants' own experience?

4.3 Process

The workshop session began by producing the output of the workshop. All participants played an active role, such as being a scribe on one of 8 flipcharts, or sharing a specific experience that others had not been exposed to.

The workshop session focused on the practitioners' needs, which included the ability to communicate effectively with management.

4.4 Results

4.4.1 A Definition of CASE

In general terms, CASE technology can be thought of as "any computer based assistance that reduces the labor intensity of project development. The group consensus was that current orientation of CASE (Computer Aided Software Engineering) thinking was not large enough. The group suggests a higher-level orientation like Computer-Aided Project Engineering (CAPE).

The group first proposed a more precise definition of CASE. It was noted that it would be unreasonable to consider implementation of lower-level development tasks (e.g., compilation, code management, debugging) without the aid of tools. Therefore, it was agreed that, for the

purposes of the workshop discussion, "CASE" would mean only "upper CASE" (diagramming and display) tools that operated on diagram types, such as:

- Data flow diagrams
- State transition diagrams
- Entity-relationship diagrams
- Control flow diagrams
- Structure charts

4.4.2 An Enabled Benefit of CASE Technology

The primary benefit of CASE tools is that they enable a defined methodology. A methodology is essentially a network of (iterative) work tasks. To benefit effectively from CASE technology, users would first have to define a methodology appropriate to their development process.

Although CASE tools (in the context selected) automate the diagramming process, they are not fundamentally a part of the methodology. It was decided that, on this level, the benefits of CASE technology can be experienced by users without the requirement of CASE tool adoption.

4.4.3 The Benefits of Automation

As part of the session, the discussion focused on the types of tasks (those which could be performed manually as part of "not buying") for which CASE automation was useful. The group then identified these tasks.

The group felt that automation should not control the development process or methodology, but rather work flexibly in support of the project. A list of the automated tasks and associated support desired from the CASE tools would then include:

- Production of documentation
- Interface connections between work tasks
- Assistance in impact analysis
- Project formalism
- Integration of higher levels of abstraction
- Enforcement of project standards and procedures

4.5 Lessons Learned

Finally, as the emphasis of the session was on CASE without tool support, the group discussed several aspects of CASE related specifically to adoption of the technology through modification or installation of the development process:

- Many methodology decisions give inadequate regard to cost.
- Management underestimates the difficulty of change.
- Productivity is the result of a well-defined process.
- Process quality, not productivity, must be the focus of change.
- Product quality will result from process quality.
- Tools will evolve in support of a viable defined methodology.

5 The "CASEability" of Projects

5.1 Theme Description

This workshop session examined a range of characteristics of a software development project, including process factors that are positive and negative indicators that a CASE tool can be successfully employed and bring beneficial results to the project.

5.2 Goal

The goals of this workshop session were twofold:

1. Identification of what attributes of a software development project are essential to introduce CASE or (if already begun) to accelerate CASE adoption.
2. Identification and recommendations of actions needed to create these essential project attributes.

5.3 Process

To accomplish the goals of this workshop session, the following brainstorming approach was employed:

1. nominate attributes
2. debate, agglomerate
3. rank attributes
4. nominate recommendations
5. debate, agglomerate
6. rank recommendations
7. review of other issues, rebrainstorm, debate, rank

Nominations were made using a simple round-robin process. The floor was closed for new nominations either when time expired, or when there were eight passes (equal the number of workshop participants) in a row.

Workshop participants voted on attributes. Each participant was allotted a fixed number of votes (equal to 1/3 the number of items to be ranked) which could be allocated to a maximum of 2 votes per attribute. The attributes with the most votes were considered the most important problem areas and resolutions to these problems were sought using the same brainstorming, voting, and ranking method.

5.4 Attributes

From the initial nomination step, 76 attributes were identified. (See Appendix C.1 for this complete list.)

5.5 Classification

A rudimentary classification scheme was proposed to identify clusters of related attributes. This classification scheme originally consisted of the following classes, with their associated attributes. Attributes could appear in more than one class.

- Pre-conditions
- Change Process/Management
- Implementation Phase - Tool
- Implementation Phase - Process/Feedback
- Implementation Phase - People
- Economics (discussion and further consideration of economic issues were tabled in view of the concurrent cost estimation session)
- Other

(For a complete cross reference of attributes and their related class assignment, subsequent agglomeration, and voting, see Appendices C.2, C.3, and C.4.)

5.5.1 Top Attributes

Summarized below are the final "top 13" attributes from this session. These attributes have the most significant bearing on the potential success of using CASE on a particular project:

- Pre-conditions
    1. commitment to training and education.
    2. acceptance of CASE tools by development team.
    3. room for failure; plan for success; mitigate risk (freedom from worth of CASE tools).
    4. sufficient lead time and resources committed plus adequate schedule.
    5. customer reinforcement (the government must have leverage to reinforce the use of CASE).
    6. commitment to well-defined standards and procedures.

- Change Process/Management

    7. champion with stature (clout).
    8. management mandate for tool usage and its products.
    9. identification of and commitment to incentives for CASE adoption, plus rewards for/recognition of success.

- Implementation Phase - Tool

    10. organizational and technical support for needed future abstractions and methods for reuse, maintainability, auto-documentation, auto-design, integration of software packages, reengineering, etc.

- Implementation Phase - Process/Feedback

    11. metric/measurement program in place plus feedback loop for improvements and lessons learned.
    12. establishment of a dedicated tools/methods/process group.

- Other

    13. SEI assessment program (similar to the Process Assessment program) for maturity of tool users and vendors.

5.6 Recommendations

Recommendations were "brainstormed" using the same nomination process used for identifying attributes. One constraint, however, was that recommendations had to satisfy (i.e., be traceable to) attributes that received 5 or more votes. From the initial recommendations step, 33 recommendations were tallied, grouped, traced, and voted upon. (See Appendix C.5 for this complete list.)

5.6.1 Top Recommendations

Summarized below are the final "top 13" recommendations from this session. When implemented, these recommendations will do the most to ensure the potential success of using CASE on a particular project:

- Develop a plan for CASE Adoption which includes: establishment of project standards and procedures, training in tools and methods, tool selection, installation, and customization.
- Create a metrics program to provide feedback for process evaluation and continuous improvement.
- Establish a dedicated process, methods, and tools group.
- Establish a management mandate for automated process, methods, and tools (i.e., CASE Adoption).

- Select CASE tools that are extensible and open to provide for future methods, abstractions, reuse, maintainability, etc., to avoid obsolescence.
- Modify MIL STD DIDS (e.g., SD, CM QA Plans) to focus on methods and plans for CASE utilization.
- Cause corporate leadership (CEO or equivalent) to designate a VPGM (or other with "clout") to be the CASE adoption leader with a mandate for action.
- Establish or join CASE adoption societies (internal or external) for mutual support, standardization, and knowledge-acquisition.
- Identify incentives and rewards (e.g., cash bonuses) for CASE adoption, creating reusable components, and implementing new technologies.
- Create a risk reduction program/guidelines for mitigating risk in the CASE adoption process.
- Establish a plan for up-front and continued training and incentives for CASE tools.
- Provide adequate schedule flexibility for CASE adoption in the procurement process to ensure adequate lead time and resource availability.
- Establish a CASE tools usage database to provide CASE user community with lessons learned.

5.6.2 Recommendations for the SEI

During brainstorming, several recommendations were made which translated into calls for SEI action. Although none of these recommendations accumulated sufficient votes to qualify as a top-rated recommendation, the workshop participants nevertheless decided to call special attention to the recommendations. These SEI-related recommendations were:

- Modify the SEI Process Assessment program to include two new scalars (tools and metrics) with an eye on the future addition of other scalars (to motivate CASE adoption).
- The SEI should author, distribute, and provide training for a CASE evaluation process to enable tool users and DoD to select CASE versus requirements.
- Form an SEI-sponsored CASE adoption SWAT team.
- Create a follow-up session to allow the group to focus on specific items like a CASE Adoption Plan.

5.7 Session Review

Only one issue of consequence was brought up during the review session. The session leader, Dr. Royce, wanted to emphasize that the current C-language orientation of CASE was a strong inhibitor to CASE adoption and evolution; he said that C is too low-level, and does not support abstraction to the degree to which, for example, C++ and Ada do. He said that he was not

advocating Ada or C++ in particular, but was merely arguing that a migration from C-level semantics to a high-order language would be extremely helpful.

5.8 Conclusion

Participants in this session noted that preconditions and management factors far outweighed technical and tool issues as key factors that are most likely to affect the successful outcome of using CASE on a particular project. While no "silver bullets" were uncovered, the session did help participants identify a number of areas in which more work is required.

6 Developing a Realistic Budget for CASE Tool Adoption

6.1 Theme Description

This session focused on the issue of providing a realistic cost estimate for CASE tool adoption. There are two key motivators for this workshop session:

1. Would-be CASE implementors too often mistakenly focus only on the acquisition cost of a CASE tool. Over the course of a CASE tool adoption, implementors may discover that CASE adoption costs are analogous to an iceberg. Just as the visible tip of an iceberg represents only 1/5 to 1/7 of its true size, the vendor's price of a CASE tool represents only a small portion of the total adoption cost of CASE. In addition to acquisition costs, CASE adoption can include significant people and time resource costs.
2. There is a critical need to inform corporate management about the expected costs of CASE adoption. This is an essential element in managing corporate expectations.

6.2 Goal

To address these issues, the initial goal of this workshop session was to discuss various cost components and prepare a framework for cost estimation to aid others in preparing their detailed CASE budgets. The framework discussed during the workshop attempted to address the following aspects:

- The cost line items that need to be taken into account. These costs include personnel, technology and other resources that must be estimated and budgeted for.
- The actions required by an organization to assimilate the CASE tool successfully, and their associated cost. These actions—training, modifying technology platforms, implementing new methods and standards—depend on the organization's readiness to adopt the CASE tool.
- The strategies available for implementation. Different strategies—gradual introduction, aggressive adoption, etc.—will have different impacts on the timing of costs.

6.3 Session Introduction

The session leader, Mr. Gonzalo Verdugo of Rubin Associates, began the discussion with an overview. His presentation included an examination of practical framework components, a description of three useful frameworks, and several CASE implementation scenarios. Mr. Verdugo reviewed several measures of organizational readiness and reviewed the SEI's Software Process Maturity Framework [22] and [11]. Finally, his presentation provided some raw cost

data from several sources such as [26], [13], [23], and a STARS-sponsored Hughes Initial and Operating CASE Investment Model.

6.4 Session Mission Statement

In the course of session discussion, the following mission statement was agreed upon:

> Establish a framework/model for detailed CASE estimate preparation and related issues. The framework should include guidelines in determining the appropriate amounts of people, time, and dollar resources for multiple projects under a single organization for CASE tool implementation.

6.5 Results

There were three main products from this session. First, there was a partial list of issues aimed at promoting topics that should be considered in the economics of CASE adoption. The general topics into which these issues fit were:

- Process
- Management
- Economics
- Organizational
- Technology
- Standards
- Implementation

The second major product was a pair of tables:

- CASE Adoption Life Cycle Estimate Matrix
- CASE Adoption Principle Cost Estimate Matrix

These two tables provide a quick overview of the major factors that affect the economics of CASE adoption. In addition, they attempt to highlight those elements that are primary cost drivers.

The third product was an action plan for further investigation and refinement of this preliminary CASE Adoption Economic Model.

6.5.1 CASE Adoption Issues

Below is a partial list of issues pertinent to the economics of CASE adoption:

6.5.1.1 Process

- Does the CASE technology you are implementing match your process?

- Are you buying a process with the CASE tool?
- Have you defined your software development process before automating it?
- Is there interaction with other processes (i.e., Systems Engineering)?
- How do you get to a certain level of process maturity to implement CASE? Is this level necessarily level 3?

6.5.1.2 Management

- What is the rationale for adopting CASE?
- What are the CASE adoption alternatives?
- What is an affordable CASE adoption strategy?
- How do you design a CASE adoption strategy to support an organizational or project mission and strategy?
- How do you identify, measure, and harvest the actual benefits or opportunities provided by CASE adoption?

6.5.1.3 Economics

- What is the cost of inaction?
- What is the cost/benefit of action and how do you maximize return on investment?
- How is CASE adoption funded?
- Is there the potential for a self-funding strategy (e.g., fee for service)?
- What is the cost of tool replacement?
- Have you considered the software, hardware, and human skill elements in your costing estimates?
- What are the total costs of a software upgrade? (This may include cost items beyond the software upgrade itself, such as a corresponding hardware upgrade.)
- Where do you get the estimates? Are the estimates (e.g., training estimates obtained from the vendor) valid? Are the estimates phase related?

6.5.1.4 Organizational

- How do you build top level understanding and commitment?
- How do you set appropriate management expectation?
- How do you educate top management?
- How does the organization adapt to technology introduction?
- How do you manage organizational change?
- What are the various roles and responsibilities in the organization?

- How does this fit with the CASE opportunity?

6.5.1.5 Technology

- What is the technology life of:

  -software?

  -hardware?

  -human skills?

- What is a reasonable timeframe for a complete technology life cycle?
- What are the differences, if any, in CASE implementation in various domains?

  -MIS versus engineering and real-time CASE domains

- What are the differences between implementation strategies?

  -distributed/centralized

  -platforms focus (mainframes/ workstations/ personal computers).

  -organizational-wide/project-oriented

- Is there a need and/or desire for suite of compatible tools?

6.5.1.6 Standards

- What is the cost of adopting or not adopting standards?
- What level of standards is appropriate?

  -tools

  -interfaces

  -methodologies/processes

  -reusable code

6.5.1.7 Implementation

- How does the organization adapt to technology introduction?
- How do you manage organizational change?
- What are the various roles and responsibilities in the organization?
- How does this fit with the CASE opportunity?
- What are the CASE adoption alternatives?
  - without top-level commitment
  - new starts versus ongoing project/evolution

- How effective are different adoption scenarios?
- Are you in an adoption mode without top-level commitment?

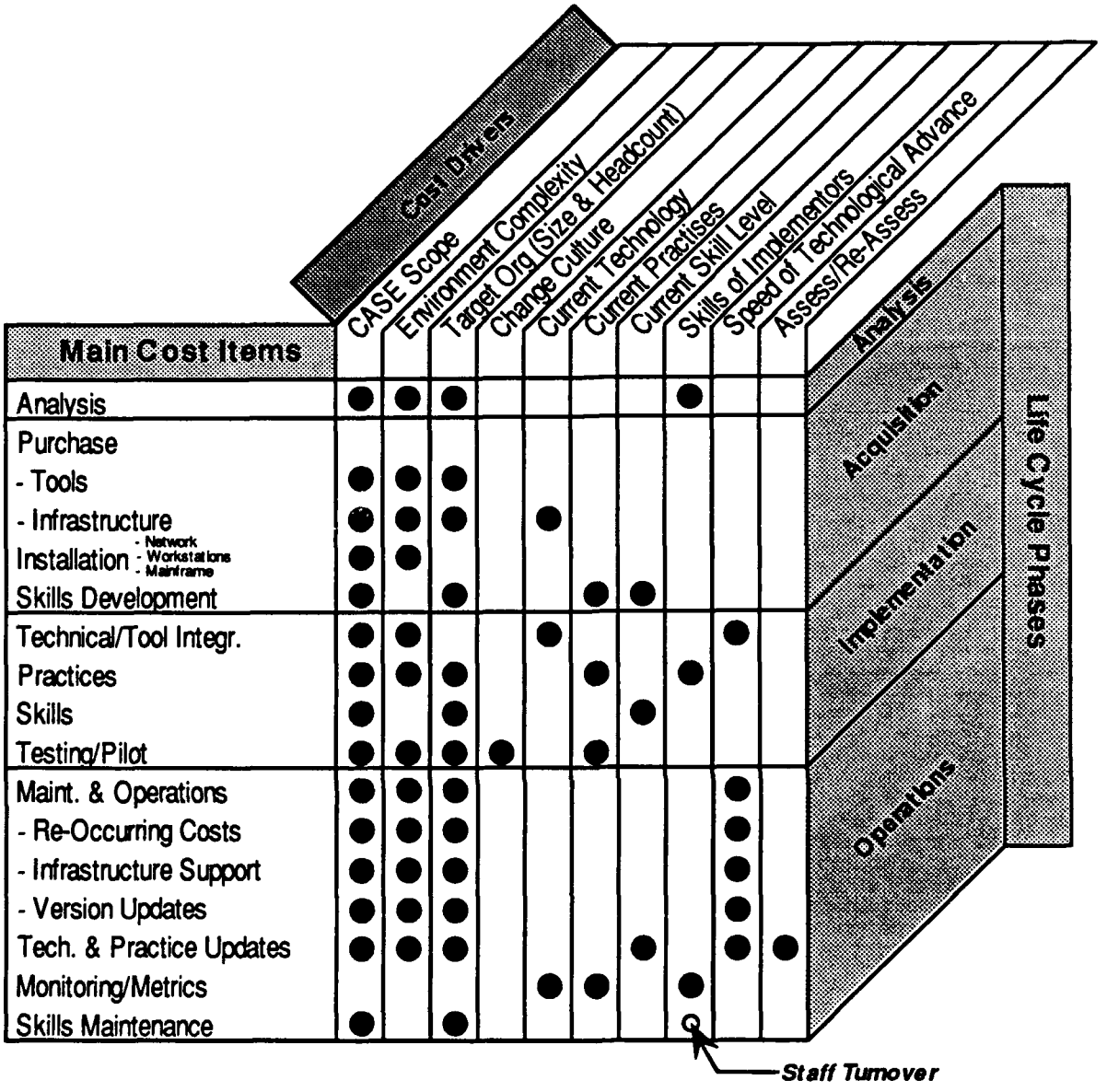
6.5.2 CASE Adoption Estimation Matrixes

The following two tables provide a quick overview of the major factors that affect economic considerations of CASE adoption. In addition, they highlight those elements that are primary cost drivers. The CASE Adoption Life Cycle Estimate Matrix table is organized by Life Cycle Phases (Analysis, Acquisition, Implementation and Operations) and HiTOP categories (Technical, Organization and People, plus an additional Management category). The HiTOP categories were adopted from the workshop keynote address by Dr. Morell of the Industrial Technology Institute. Overall, these tables are designed to motivate potential planners to consider a wide range of factors that can influence the cost of CASE Adoption.

CASE Adoption Life Cycle Estimate Matrix

Categories	Life Cycle Phases: Analysis	Acquisition	Implementation	Operations
Technical	***Assessment*** - Technology - State of Practice - Needs Establish Requirements Architecture Definition	Selection - Vendor/Tool - Tool Integ. Strategy ***Purchase*** - Negotiations - Strategy - ***Tools*** ***Infrastructure*** - Network - Mainframe - Workstations Installation - Site Preparation	***Technical*** - ***Tool Integration*** Metrics Analysis ***Testing*** - ***Pilot*** Infrastructure Support	***Maint. & Operations*** - ***Re-Occurring Costs*** -- License Fees -- Personnel -- Facilities - ***Infrastructure Spt*** - ***Version Update*** ***Technology Infusion*** **Reassessment** *go back to Analysis Phase*
Organization	***Assessment*** - Process - Culture	Cultural Change Mgt	***Practices*** - Q/A & Conf Mgt - New/Revised - Documentation Cultural Change Mgt - User's Groups	*Practices* - Q/A & Conf Mgt - New/Revised - Documentation Cultural Change Mgt - User's Groups
People	***Assessment*** - Skills	***Skills Development*** - Implementors - Users	***Skills Development*** - Training/Education - Coaching - Hiring	Skills Maintenance
Mgt	Committment Building Monitoring	Committment Maint. Monitoring	Committment Maint. Monitoring Metrics Review	Committment Maint. ***Monitoring*** ***Metrics Review***

Table 2 CASE Adoption Life Cycle Estimate Matrix



Key Assumption:
There is a commitment to change from management and target users.

Table 3 CASE Adoption Principle Cost Estimate Matrix

6.6 Next Steps

Additional work is necessary to achieve our original mission objectives completely. We need to complete the design of our cost model. In doing so, we need to address the pertinent issues raised in this workshop session. These include development of rules of thumb and algorithms for estimation. We hope that we can develop a set of estimation algorithms structured in a

manner like the COCOMO software cost estimate model [2]. We should also develop a guide book for the estimation process. Next, a number of case studies should be done to verify the accuracy of the model. And finally, the model should be made available for use in a trial period during which important feedback and lessons learned can be incorporated into the model.

6.7 Conclusion

The material included in this section provides essential information to those who must prepare composite estimates for implementing CASE in their organization. It provides a high-end framework that serves as a checklist of elements to consider when developing an organization-specific cost estimate. As described above, the next step in this process is the development of an algorithmic cost model to aid in the CASE adoption estimation process.

In addition to this high-end framework, there still is an important need for detailed information about specific tools and vendors. Those who have this need may refer to Appendix D, CASE Resource Pointers. In this appendix, there are 8 tables that provide a useful set of pointers to different sources of information on CASE tools. While not all-inclusive, this information exemplifies the type of information that is available from commercial and government sectors.

7 Making the CASE Tool Fit the Organization and the Organization Fit the Tool

7.1 Theme Description

All organizations have difficulty coping with change. This concept certainly applies to a company's decision to incorporate CASE. The focus of this workshop session was to examine some of the changes that an organization may need to make if tool adoption is to be successful, and to identify the modifications that may be required of tools and tool vendors.

7.2 Goal

The goal of this workshop session was to identify tool and organizational characteristics that facilitate or inhibit CASE adoption.

7.3 Discussion Topics

In pursuit of this goal, the subsequent discussion focused on four topic areas:

1. Tool characteristics that facilitate CASE adoption
   - Customizable
   - Integratable
   - Vendor support
   - Extensibility
   - Documentation
   - Platform independence
2. Tool characteristics that inhibit CASE adoption
   - Failure to adopt industry trends
   - Poor performance
   - Tool proprietary methodologies
   - Single-user versus multi-user tools
3. Organizational characteristics that facilitate CASE adoption
   - Defined/understood processes and standards
   - Training
   - Communication
   - Management support for implementation
   - Ongoing support
4. Organizational characteristics that inhibit CASE adoption
   - Cost

- Maintenance versus new development
- Heterogeneous development environment

Each topic was discussed in terms of the following factors (as applicable):

- Definition
- Examples
- How to implement
- Risks

7.4 Tool Characteristics That Facilitate CASE Adoption

7.4.1 Customizable

Definition: Ability to tailor the tool's features and functions to the organization's needs.

Examples:

- Report contents and formats.
- User-defined symbols and checking rules.
- Ability to respond to changes in the work flow (e.g., tool that will allow you to "check in" a diagram that is not semantically correct).
- Ability to facilitate the production of documentation.

How to Implement:

- Customization may be done by:
  - group
  - company
  - project
  - user-by-user
  - centralized
  - through a clearing house
- There should be an entity responsible for customization

Risks:

- Maintenance of versions of customized tools and environments
- Providing inadequate support of the process of customization.
- Not fully understanding the complexity of customization.
- Customization may violate a tool-enforced standard.
- Customization may sacrifice a feature of a tool (e.g., can't use consistency checking features if you've redefined what a symbol means

in a diagrammatic tool).

7.4.2 Integratable

Definition: Information captured by one tool accessible to other tools in Software Development Environment (SDE); ability to initiate and accept information from other tools in SDE.

Examples:

- EIA CDIF CASE data interchange
- Message passing—Softbench Message Server
- Linking—Sun's link services

How to Implement:

- Many models—outside the scope of this workshop.

Risks:

- Too much faith in immature technology.
- Demonstrated only for programming in the small; questionable scalability.
- Semantic integration—two tools tightly coupled act as third tool, with indeterminate characteristics.

7.4.3 Vendor Support

Definition: Quality training, timely technical support, user groups, support for customization, mechanisms for accepting inputs on enhancements or bugs; provided by vendor.

How to Implement:

- Get an evaluation copy of tool
- Get an evaluation copy of documentation
- Attend vendor training
- Attend user group meetings

7.4.4 Extensibility

Definition: Adding functionality and value to the tool; goes beyond customization.

7.4.5 Documentation

Examples: User manual, reference manual, tutorial, on-line help, meaningful diagnostics, master index, reference card, supplementary texts (for supported methods).

Risks:

- Not enough documentation.
- Not clear enough for user to learn basics of tool quickly.
- Potential "shelf-ware."

- Updates/change pages do not occur with tool upgrades.

7.4.6 Platform Independence

Definition: Tool has ability to share information and control across platforms (interoperability). Tool operates on a variety of platforms.

Examples:

- X-windows, NFS (hide platform variations)

How to Implement:

- Tool makes use of X-window interface, or is able to reside on NFS

Risks:

- Buying into a proprietary solution

7.5 Tool Characteristics that Inhibit Adoption

7.5.1 Failure to Adopt Industry Trends

Examples:

- Tool linked to obsolete/restricted platforms and environments.
- Tool can't accommodate evolving methods.

Risks:

- Not tracking standards and trends diminishes tool's ability to interoperate, integrate, and be portable.

7.5.2 Poor Performance (of Tool)

How to Implement:

- Plan/manage project growth
- Recognize requirements (tool, platform, software)

Risks:

- Productivity
- Scalability
- Frustration—tool so slow to use, all CASE use is terminated

7.5.3 Tool Proprietary Methodologies

Risks:

- Training & literature may not be readily accessible.
- Client does not readily accept.
- Evolution is restricted.

- Customer may be locked in to one vendor's tool and/or methodology.
- Tool proprietary methodologies may not ever be a *de facto* or official standard.
- Tool can't be re-used or shared.

7.5.4 Single-User Versus Multi-User

Definition: Stand-alone versus cooperative environment (real time).

Risks:

- Single user— isolation, inadequate CPU and disk resources.
- Multiple user—security and configuration management; inadequate network resources, cpu, disk, etc.
- Both—performance, scalability, availability.

7.6 Organizational Characteristics That Facilitate CASE Adoption

7.6.1 Defined/Understood Processes and Standards

Examples:

- 2167/2167A
- Home-brewed cookbook (site-specific)
- Folklore or company culture
- Company proprietary

How to Implement:

- Marry tool with process (nontrivial & generally underestimated).

Risks:

- Conflict between tool and organization structure and process.
- Reliance on tool to set the process—may be beyond tool's capabilities.
- Potential to buy wrong tool set.
- Inconsistent tool use (example: two people using same tool, yet using completely different naming conventions—tool can't enforce a naming convention!).

7.6.2 Training

Definition: Training in methods, tool, and customization

Examples:

- Hands-on training (very important)
- On-line training
- Training assistance from in-house "centers of excellence"

How to Implement:

- In-house support capability
- Consistent vendor-supplied training
- Provided for consultants, new hires, etc.

Risks:

- Misuse and inconsistency.
- Insufficient frequency and/or timeliness (too soon, too late, not often enough for all employees).
- Irrelevance—the examples in the training sessions are far removed from the user's domain
- User frustration.
- Unrealistic expectations—training can't make a person an expert.

7.6.3 Communication

Examples:

- Promote between champions and coaches
- "Sign-off" & buy-in from all relevant groups (QA agrees in tool's representation, CM agrees tool's objects will be stored, etc.); connect with the multiple disciplines involved in managing project (QA, CM, etc.)
- Pass lessons learned to future projects.
- Use electronic bulletin boards.
- Use tool itself to support structured communication—through project management, conferencing, notes, on-line (extensible) documentation.

Risks:

- Champion with hidden agenda.
- Chaos.
- Excessive or overly formal communication.
- Lack of focus (e.g., 18 different newsletters for one division, no one reads them).
- False perceptions.
- Communication clouded by politics—newsletters seen by customer contain only "happy talk."
- "Filters" for communications.
- "Blinders"—people don't avail themselves of communication mechanisms available.

7.6.4 Management Support for Implementation

How to Implement:

- Sanction and support for pilot projects.
- Accommodation— $$$$ (funding available for purchase).
- Planning, schedules, and ancillary development.
- New infrastructure.

Risks:

- Mandate without buy-in at lower levels (can't get developers to use).
- Grassroots movement without management support.
- Politics & self-fulfilling prophecies (you can try it, but it won't help you anyway).
- Lack of interdepartmental buy-in/support.
- Poor planning of time & resources.
- External customer perspectives—customer should understand the actual cost and schedule impacts of CASE adoption; customer should not expect CASE to revolutionize the organization, but to impact the organization in an evolutionary way.

7.6.5 Ongoing Support

How to Implement:

- Maintenance—track evolution in tools and process.
- System administration of tool—install upgrades.
- Continue training.
- Use coaches.
- Provide feedback loop for future uses of tool.

Risks:

- Tool becomes obsolete.
- Misuse—user expertise lags behind tool/technical capabilities.
- Compatibility—different versions of same tool; can't share data, versions get out of synch.

7.7 Organizational Characteristics That Inhibit Adoption

7.7.1 Cost

- Deferring to "Developing a Realistic Budget for CASE Tool Adoption" session.

7.7.2 Maintenance Versus New Development

Risks:

- CASE not always applicable to existing system (maintenance).

- Reliance on "reverse engineering will solve our problems" (new development).
- CASE tools aren't used early enough to capture information.
- The state of design automation is not recognized—different types of design.
- Although "reengineering" techniques have been around since the 70's, automation isn't available for it yet.

7.7.3 Heterogeneous Development Environment

Definition: Tool and platform choices may be restricted to what has currently been purchased by the organization.

Examples:

- Many machines
- Operating systems (VMS, OS/2, UNIX, etc.)
- Graphical user interfaces (OSF/Motif, OpenLook, Present Manager, etc.)
- Networks (NFS, DECNET, PCNET, etc.)

How to Implement:

- The trend is towards heterogeneous development environment (what vendor is selling the least expensive box this month).

Risks:

- Prediction of future environments and technology is difficult.
- Tool vendors aren't tracking trends.
- Users are required to know many different systems.

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Appendix A Registration List

Edward L. Averill
MTS
Software Engineering Institute
Process Program
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-6818
eia@sei.cmu.edu
FAX: (412) 268-5758

Maurice H. Blumberg
Advisory Engineer
IBM Corporation
800 N. Frederick Ave.
Gaithersburg, MD 20879
(301) 240-6018
FAX: (301) 240-6073

Jack Bond
Software Engineering Staff
National Security Agency
Ann: T303
9800 Savage Road
Fort George Meade, MD 20755-6000
(301) 668-7691

Sandy Brenner
Software Engineering Institute
CASE Technology
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-3444
seb@sei.cmu.edu
FAX: (412) 268-5758

William J. (Jack) Brownlow
Automation Requirements Mgr.
Boeing Defense & Space Group
Aerospace and Electronics
P.O. Box 3999
M.S. 87-67
Seattle, WA 96124
(206) 773-0578
FAX: (206) 773-4946

Batia Dane
Senior Member of Technical Staff
GTE
Government Systems Corp.
77 "A" Street
Needham Heights, MA 02194-2892
(617) 455-5366
FAX: (617) 435-5365

Odean Bowler
Software Engineer
Software Technology Support Center
CASE Tools/Environments
OO-ALC/TISAC Bldg. 100
Hill AFB, UT 84056
(801) 777-7703
FAX: (801) 777-8069

Hillary R. Davidson
Knowledge Program Engineer
Hewlett-Packard
Software Engineering Systems Division
3404 East Harmony Road
Fort Collins, CO 80525
(303) 229-2338
FAX: (303) 229-2180

Anna Deeds
Naval Sea Systems Command
PMS-4123G1
Washington, DC 20305-5101
(703) 602-8204
FAX: (703) 602-2070

Grace F. Downey
Member of Technical Staff
Software Engineering Institute
Software Development Environments Project
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-7601
downey@sei.cmu.edu
FAX: (412) 268-5758

Robert Ellison
Manager
Software Engineering Institute
Computing Facilities
Pittsburgh, PA 15213-3890
(412) 268-7705
ellison@sei.cmu.edu
FAX: (412) 268-5758

Greg Engledove
Naval Sea Systems Command
PMS-4123G1
Washington, DC 20305-5101
(703) 602-8204
FAX: (703) 602-2070

Priscilla Fowler
Member of Technical Staff
Software Engineering Institute
Technology Applications
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-7748
pjf@sei.cmu.edu
FAX: (412) 268-5758

Steven P. Fried
Senior Computer Scientist
Computer Sciences Corporation
Integrated Systems Division
220 Park Ave.
Atco, NJ 08004
(609) 234-1100 x2998
FAX: (609) 727-9496

Jay Gibbons
Director, Software Engineering
E-Systems, Inc.
HRB Systems
P.O. Box 60
State College, PA 16804
(814)238-4311 x3156
jjg@icf.hrb.com
FAX: (814) 234-7720

James A. Hager
Manager, Software Techniques
E-Systems, Inc.
HRB Systems
P.O. Box 60
Science Park Road
State College, PA 16804
(814) 238-4311 x3192
j2h@icf.hrb.com
FAX: (814) 234-7720

Glenn Harmon
Air Staff Software Plans Mgr.
United States Air Force
HQ USAF/SCXS
Washington, DC 20330
(703) 614-7027
harmon@sc4.hq.at.mil
FAX (703) 695-4022

Gibbie Lu Hart
Computing Facilities Manager
Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-7780
gibbie@sei.cmu.edu
FAX: (412) 268-5758

Clifford C. Huff
Member of Technical Staff
Software Engineering Institute
CASE Technology Project
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-7605
cch@sei.cmu.edu
FAX: (412) 268-5758

Charles F. Koch
Branch Head, Software Eng. Technology
Naval Air Development Center
Code 7031
Warminster, PA 16974-5000
(215) 441-2462
hoch@nadc.navy.mil
FAX: (215) 441-3225

John T. LeBaron
Computer Scientist
US Army CECOM
Software Process Eng. Technology
AMSEL-RD-SE-AST-SE
Fort Monmouth, NJ 07703
(201) 532-2241
FAX: (201) 532-4129

Roy B. Levow
Associate Professor
Florida Atlantic University
Department of Computer Science
P.O. Box 3091
Boca Raton, FL 33431 0991
(407) 367-3927
roy@cs.fau.edu
FAX: (407) 367-2800

Bruce Lewis
Computer Engineer
US Army Missile Command
AMSMI-RD-BA-AD
Redstone Arsenal, AL 35898
(205) 876-3224
FAX (205) 876-1458

John H. Maher, Jr.
MTS
Software Engineering Institute
Products and Services
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-6309
jhm@sei.cmu.edu
FAX: (412) 268-5758

Bill McSteen
Writer/Editor
Software Engineering Institute
Information Management
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-6373
wkm@sei.cmu.edu
FAX: (412) 268-5758

Roger Moos
Resident Affiliate, Computer Sciences Corp.
Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-6533
rm@sei.cmu.edu
FAX: (412) 268-5758

Jonathan A. Morell
Senior Researcher
Industrial Technology Institute
2901 Hubbard Road
Ann Arbor, MI 48106
(313) 769-4395
jam@iti.org
FAX: (313) 769-4064

Joe Morin
Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-8594
jfm@sei.cmu.edu
FAX: (412) 268-5758

Ed Morris
Member of the Technical Staff
Software Engineering Institute
CASE Technology Project
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-5754
ejm@sei.cmu.edu
FAX: (412) 268-5758

Jay Pollack
Consulting Engineer
Computer Sciences Corporation
System Sc. · · Division
4600 Powder Mill Road
Beltsville, MD 20705
(301) 572-8413
FAX: (301) 937-0818

Jock A. Rader
SR. Lab Scientist
Hughes Aircraft Company
Radar Systems Group
Box 92426(R11/11001)
Los Angeles, CA 90009
(213) 607-3488
FAX: (213) 334-2642

Winston W. Royce
Director, Software Dev. Technology
TRW System Integration Group
12450 Fair Lakes Circle
Suite 8140
Fairfax, VA 22033
(703) 988-4086

Dennis B. Smith
Project Leader, CASE Technology Project
Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-6850
dbs@sei.cmu.edu
FAX: (412) 268-5758

Albert Soule
Software Engineering Institute
Technology Transition
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-6821
als@sei.cmu.edu
FAX: (412) 268-5758

Kimberly Stepien-Oakes
Government Resident Affiliate
Software Engineering Institute
CASE Technology Project
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-5789
kstepien@sei.cmu.edu
FAX: (412) 268-5758

A. D. Stuart
Assistant for SW & Systems
Department of the Navy
DASN (IRM)
Bldg. 166
Washington Navy Yard
Washington, DC 20374
(202) 433-3499
FAX: (202) 433-0719

Andrew Tsounos
Member of Technical Staff
Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-6304
agt@sei.cmu.edu
FAX: (412) 268-5758

Richard (Rick) T. Turley
R&D Section Manager
Hewlett-Packard
Software Engineering Systems Division
3404 East Harmony Road
Mail Stop 7
Fort Collins, CO 80526
(303) 229-2340
rickt@hpfclp.sde.hp.com
FAX: (303) 229-6611

Gonzalo Verdugo
Howard Rubin Associates
43 Highland Ave.
Lexington, MA 02173
(617) 862-6748
FAX: (617) 862-6748

Kurt C. Wallnau
Member of Technical Staff
Software Engineering Institute
Software Methods
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-3660
kcw@sei.cmu.edu
FAX: (412) 268-5758

Laura Wikle
Computer Scientist
Naval Surface Warfare Center
Code E323 Dahlgren, VA 22448
(703) 663-7804
FAX: (703) 663-7440

Nicholas Wybolt
Director, Architecture and Environments Eng.
Cadre Technologies, Inc.
222 Richmond Street
Providence, RI 02903
(401) 351-5950
...!sun!cadreri!nw
FAX: (401) 351-7380

Paul Za..ella
Member of Technical Staff
Software Engineering Institute
CASE Technology Project
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-3156
pfz@sei.cmu.edu
FAX: (412) 268-5758

Appendix B Workshop Session Assignments

B.1 Adoption Roles and the Adoption Life Cycle for CASE

Session Leaders

Priscilla Fowler, Software Engineering Institute
John Maher, Software Engineering Institute

CASE Project Member

Ed Morris, Software Engineering Institute

Scribe

Joseph Morin, Software Engineering Institute

Participants

Odean Bowler, Air Force Software Technology Support Center
Hillary Davidson, Hewlett-Packard
Greg Engledove, Department of the Navy
Roy B. Levow, Florida Atlantic University
Jonathan A. Morell, Industrial Technology Institute

B.2 Can You Get the Benefits of CASE Without Buying?

Session Leader
Ed Averill, Software Engineering Institute

CASE Project Member
Paul Zarrella, Software Engineering Institute

Scribe
Andy Tsounos, Software Engineering Institute

Participants
Jim Hager, HRB Systems, Inc.
Charles F. Koch, Navy NADC
Laura Wikle, Navy NSWC

B.3 Developing a Realistic Estimate for CASE Tool Adoption

Session Leader
Gonzalo Verdugo, Howard Rubin Associates

CASE Project Member
Clifford Huff, Software Engineering Institute

Scribe
Gibbie Hart, Software Engineering Institute

Participants
Jack Bond, National Security Agency
William J. Brownlow, Boeing Aerospace and Electronics
Anna Deeds, Department of the Navy
Glenn Harmon, USAF
Albert Soule, Software Engineering Institute
John LeBaron, US Army CECOM
Toni Stuart, Department of the Navy

B.4 The CASEability of Projects

Session Leader
Win Royce, TRW

CASE Project Member
Kim Stepien, National Security Agency

Scribe
Kurt C. Wallnau, Software Engineering Institute

Participants
Maurice H. Blumberg, IBM Corporation
Jay Gibbons, HRB Systems, Inc.
Bruce Lewis, US Army MICOM
Roger Moos, Computer Sciences Corporation
Rick T. Turley, Hewlett-Packard

B.5 Making the CASE Tool Fit the Organization and the Organization Fit the CASE Tool

Session Leader
Steven Fried, Computer Sciences Corporation

CASE Project Member
Dennis Smith, Software Engineering Institute

Scribe
Grace Downey, Software Engineering Institute

Participants
Batia Dane, GTE Government Systems Corporation
Jay Pollack, Computer Sciences Corporation
J. A. Rader, Hughes Aircraft Company
Nick Wybolt, Cadre Technologies Inc

Appendix C The CASEability of Projects

C.1 Complete Attributes List from Initial Brainstorm

1. Acceptance by development team.
2. Real demand for the tool *(development team has a need for the tool).*
3. Establish successful processes prior to tool selection (vs. opposite).
4. Strong management commitment.
5. Clear objectives for quality and productivity improvement.
6. General structured methodology acceptance *(not necessarily structured analysis, but any general methodology).*
7. Room for failure; plan for success; mitigate risk (freedom from worth of CASE tools).
8. Neutralizing "not invented here."
9. Tool cohesion *(the way tools interact with each other).*
10. Customer reinforcement *(the government must have leverage to reinforce the use of CASE).*
11. Enumerated/documents requirements for CASEability of the project.
12. Champion with stature (clout).
13. Desire and motivation for change.
14. Commitment to training and education.
15. Cultural change experts *(to help with the change process vs. technical issues).*
16. Guaranteed tool maintenance, e.g., vendor viability.
17. Real solution to the environment evolution problem—impact of tool evolution on environment.
18. Tool that provides control and productivity gains.
19. Plan to mitigate probability of failure to 0%.
20. Sufficient lead time and resources committed plus adequate schedule.
21. Capturing and storing lessons learned.
22. Feedback loop for improvements and lessons learned.
23. Real cost estimation and ROI *(return on investment)* justification (tool/process/implementation).
24. Adequate schedule and management attention to keep schedule adequate.

25. Metric/measurement program in place plus feedback loop for improvements and lessons learned.
26. Commitment to well-defined standards and procedures.
27. Reward and recognize success.
28. Commitment to developing in-house tools to help with integration of tools.
29. Commitment to spending time studying environment.
30. Openness to COTS/NDI *(commercial off-the-shelf/non-developmental items)*.
31. Flexibility to absorb new unforeseen developments *(integrate change)*.
32. Viable measure of tool quality (i.e., CASE consumer reports).
33. Manager mindset change from hardware to software orientation.
34. Support organization impacted accounted for (e.g., CM *(Configuration Management)*, data, QA *(Quality Assurance)*, training)
35. Availability of/access to CASE experts.
36. Staffed process group.
37. Commitment from tool vendors to incorporate user feedback.
38. Organizational and technical support for needed future abstractions and methods for reuse, maintainability, auto-documentation, auto-design, integration of software packages, reengineering, etc.
39. Tool composability (syntactic and semantic).
40. Flexibility to update tool for new methods and methodology improvements.
41. Adequate hardware platform resources.
42. Skills/experience/attitude of technical team.
43. Recognizing the difference between MIS and real-time environments.
44. Openness/access to tool vendor code.
45. Monitoring the use of tools by QA enforcement.
46. Multiple access paths to tool features.
47. Financial (i.e., longevity) assurance of vendors.
48. Extent of the cultural change of the organization.
49. Commitment to educate customer/procurement regarding CASE technology.
50. Standard interface across tools.

51. Nationwide standardization of tool control, data passing.
52. Management mandate for tool usage and its products.
53. Proof of the adoption life-cycle.
54. Access to CASE environments, tools evaluation data (consumer union for tools).
55. Overcome "camcorder syndrome" (i.e., just pick a tool, don't wait for all the features).
56. Identification of and commitment to incentives for CASE adoption, plus rewards for/recognition of success.
57. Don't expect it to be easy.
58. How to create incentive for tool vendors to provide tool cohesion.
59. Tailorability to project users.
60. Require market pressures for open systems.
61. Evaluate more than the software, but rather the quality of the engineering attributes (of products).
62. Inject academic programs with the CASE notion.
63. Previous experience *(of developers)* with CASE tools/methods.
64. Get the government to stop the "paper game."
65. Why does the DoD think they have to invent tools and environments?
66. Size, complexity, documentation requirements must be handled by CASE.
67. Sensitize your customer or investor to CASE prior to "the eleventh hour." *(waiting until the last minute when it's too late)*
68. Establishment of a dedicated tools/methods/process group.
69. Organizational commitment to utilize CASE technology for re-engineering and maintenance.
70. Set organizational/customer expectations re. productivity/quality for CASE use.
71. Recognize language independence for most CASE situations.
72. Encourage CASE "skunkworks" *(projects experimenting on their own initiative).*
73. SEI assessment program for tool users and tool vendors for their maturity ala the process assessment program.
74. Dispel job loss fears from the adoption of CASE.

75. Use all possible communication paths to sell CASE.

76. Create non project-specific learning groups/skunkworks to investigate the CASE domain.

C.2 Attribute Classification

A rudimentary classification scheme was proposed to identify clusters of related attributes. This classification scheme originally consisted of the following classes, with their associated attributes. Attributes can appear in more than one class.

Pre-conditions:

1	2	3	4	6
7	10	13	14	19
20	24	26	48	57

Change Process:

8	12	13	15	33
34	35	49	52	53
55	67	69	70	72
75	76			

Implementation Phase - Tool

9	11	16	17	18
28	31	32	37	38
39	40	41	43	44
46	47	50	51	54
58	59	66	71	

Implementation Phase - Process/Feedback

3	5	10	21	22
24	25	26	29	32
36	45	53	54	61
68				

Implementation Phase - People

1	27	42	63	74

Economics

23	41	56	66	

Other

30	50	51	58	60
62	64	65	73	

C.3 Attribute Agglomeration

Of the original 73 attributes, several were merged. In the following merge table, the leftmost attribute number indicates the main attribute into which other attributes have been merged.

Main Attribute	Merge
1	8
52	4
5	70
6	19
16	47
32	54
50	51
58	9, 39
70	5
76	72

The following attributes were merged or removed from consideration because of obvious overlap with other attributes: 6, 21, 22, 23, 24, 27.

C.4 Attribute Voting

The following table summarizes the voting on the attributes. It was decided by acclamation that those attributes receiving fewer than 5 votes would not be considered further.

Votes	Attributes
9	12, 14, 25, 52, 68
8	38, 56
7	1, 7, 20,
5	10, 26, 73
4	2, 3, 30, 50, 70
3	13, 28, 32, 44, 59, 66
2	11, 17, 41, 42, 58
1	16, 35, 37, 46, 48, 49, 60, 75

C.5 Recommendation from Initial Brainstorm

1. Establish a dedicated process, methods, and tools group.
2. Establish a management mandate for automated process, methods, and tools (i.e., CASE Adoption).
3. Create a risk reduction program/guidelines for mitigating risk in the CASE adoption process.
4. Establish a plan for up-front and continued training and incentives for CASE tools.
5. Educate users on change management.
6. Use SEI process evaluation to motivate CASE Adoption.
7. Provide adequate schedule flexibility for CASE adoption in the procurement process to ensure adequate lead time, resources, budget are applied by contractors.
8. Create a metrics program to provide feedback for process evaluation and continuous improvement.
9. Develop a plan for CASE Adoption which includes: establishment of project standards and procedures, training in tools and methods, tool selection, installation, and customization.
10. Modify the SEI Process Assessment program to include two new scalars (tools and metrics) with an eye on the future addition of other scalers (to motivate CASE adoption).
11. Create rewards program related to CASE.
12. Write CASE Adoption plan; tie CASE Adoption to revenue producing activities; compute ROI goals.
13. Establish a CASE Tools usage database to provide CASE user community with lessons learned.
14. Government contracts and program management should support CASE Adoption and use throughout the lifecycle.
15. Modify MIL STD DIDS (e.g., SD, CM QA Plans) to focus on methods and plans for CASE utilization.
16. Establish data standards working group at time of implementation.
17. Cause corporate leadership (CEO or equivalent) to designate a VPGM (or other with "clout") to be the CASE adoption leader with a mandate for action.
18. Suggest to tool vendors: provide for extensibility to provide for software reuse, re-engineering, and maintenance.

19. Consider development culture as an important aspect of tool selection.
20. CASE tools must be extensible and open to provide for future methods, abstractions, reuse, maintainability, etc., to avoid obsolescence.
21. Commit to up-front costs for time and training for CASE adoption.
22. Develop a plan for new technology insertion to allow for methods and tools enhancements as CASE technology evolves.
23. The SEI should author, distribute, and train a CASE evaluation process to enable tool users and DoD to select CASE vs. requirements.
24. Inform development team on what will change and not change.
25. Use a CASE Adoption corporate newsletter to build the team, advance mandate, et. al.
26. Create an SEI-sponsored CASE adoption SWAT team.
27. Create non-project-specific related CASE working groups.
28. Expect to help projects risking first usage of CASE; motivate them by support to accept some risk (e.g., through contractual mechanisms).
29. Create ongoing CASE training program with incentives for project involvement.
30. Identify incentives and rewards for CASE adoption and creating reusable components and implementing new technologies (e.g., cash bonuses).
31. To "jump-start" CASE experience acquisition offices should use a front-end CASE tool to generate in total the software procurement packages.
32. Contractor organizations should use a front-end CASE tool to develop a proposal package in total.
33. Establish or join CASE adoption societies (internal or external) for mutual support, standardization, and knowledge-acquisition.

C.5.1 Recommendations Agglomeration

Main Recommendation	Merge
4	29
9	12, 19, 21, 22
15	14
20	18
33	27

C.5.2 Recommendations Traceability

The following table describes the traceability of recommendations to requirements.

Recommendation	Attribute
1	68
2	52
3	7
4	14
5	1, 14
6	12, 52
7	20
8	25
9	14, 26
10	12, 52, 73
11	56
12	12, 52
13	17
14	10
15	10, 12, 52
16	7, 26
17	12, 52
18	38
19	1
20	38
21	14, 20
22	38
23	vbvb10, 38, 73
24	1
25	1
26	10
27	7
28	1, 7, 56
29	14, 56
30	38, 56
31	10
32	14, 56
33	1, 26, 38, 68

C.5.3 Recommendations Votes

It was decided by acclamation that recommendations receiving fewer than four votes would not be considered further. It was demonstrated that all attributes were satisfied by the recommendations receiving four or more votes.

Votes	Recommendation
11	9
9	8
6	1, 2, 10, 15, 17, 33
5	30
4	3, 4, 7, 13
2	5, 18, 23, 25, 26, 28, 32

C.6 Observations on Brainstorming

The brainstorming technique was a great technique to get the issues out in the open for discussion. However, it was difficult to "remove" an issue once it was listed. Even if several people disagreed with an issue, it remained on the list and was voted on. Voting weeded out most of the nonessential issues, but there should have been time to argue for removal of items.

The participants in this session worked very effectively. Within the first 10 minutes of the session, each group member had some responsibility to the group (timekeeper, scribe, etc.). This helped to break down the initial group apprehensiveness and allowed the group to focus on its tasks. The brainstorming technique also allowed group members to participate without being subject to rejection.

The topic for this session was actually very broad and a large amount of time was spent simply listing the issues. The session leader, Dr. Royce, commented that he was very surprised that the group had over 70 attributes from the initial brainstorm and it was unusual to have such a high number.

Appendix D CASE Resource Pointers

The following tables provides a useful set of pointers to a number of different sources of information on Computer-Aided Software Engineering (CASE) tools. This information, while not all-inclusive, does exemplify the type of information that is available from commercial and government sectors.

The 8 tables that follow are:

- Table D-1 U.S. Government CASE Information Sources
- Table D-2 CASE Industry-specific Reports/Directories
- Table D-3 CASE Industry-Specific Magazine-Based Buyer's Guides
- Table D-4 General Software Industry Reports/Directories
- Table D-5 Consulting Groups/Conferences
- Table D-6 Case Industry Newsletters
- Table D-7 CASE Trade Shows
- Table D-8 CASE User's Groups

Name	Contact/Source	Comment
GSA CASEbase	Judith Andrews GSA/OSDIT 5203 Leesburg Pike Suite 1108 Falls Church, VA 22041 (703) 756-4500	*CASE database of vendors/ tools and government users/ evaluators*
STSC CASE Database/ Toolbox PC	Air Force Software Technology Support Center Reuel Alder OO-ALC/TISAC Air Force Software Technology Support Center Hill AFB, UT 84056 AV 458-8045 (801) 777-8045	*Also contact for Joint Software Support Conference April-1992 Salt Lake City, UT Sponsored by HQ USAF/SC and the Pentagon*
Systems Engineering Tools for Computer-Aided Design of Ultra-Reliable Systems	Appendix A, Table A-10 CASE Tools BATTELLE Tactical Technology Center 505 King Avenue Columbus, OH Sponsorsed by DARPA Available thru Defense Technical Information Center (202) 274-6847	*Table of 173 CASE tools*
Reviews of Selected System and Software Tools for Strategic Defense	Institute for Defense Analyses IDA Paper P-2177 Alexandria, VA Defense Technical Information Center Session Number ADA226 982 (703) 274-7633	*Covers Software through Pictures, Teamwork, TAGS, Auto-G, DCDS, RDD, Statement, Refine, Design/ IDEF, 001, Foresight, Virtual Softtware Factory & Adagen*
Evaluation of Existing CASE Tools for Tactical Embedded System	CECOM Center for Software Engineering US Army CECOM AMSEL-RD-SE-AST-SE Ft. Monmouth, NJ 07703 (908) 532-2342	*Covers Teamwork, ProMod, EPOS, Software through Pictures, Statemate, Autocode, Model, CCC, Foresight, T & SuperCASE*
Software Engineering TOOLS CATALOG	The Aerospace Corporation ATR-0089(8115)-1 El Segundo, CA 90245-4691	*Covers Anatool, DataViews, Design Aid, Docwriter, Excelerator, FDM, Nexpert Object, PIES, P-NUT, PowerTools, Software Size Estimator, Software through Pictures, Statemate, Teamwork, TekCASE*

Table D-1 U.S. Government CASE Information Sources

Source	Address/Phone	Title	Price
ACM SIGSOFT Software Engineering Notes vol 15 no1 'Jan 1990 Page 79	Project SYTI Dept of Computer Science University of Jyv skyl Seminaarinkatu 15 SF-40100 Jyv skyl FINLAND	*An Annotated CASE Bibliography*	n/a
BIS CAP International	POB 68 Newtonville, MA 02160 (617) 893-9130	*Implementing CASE: A Manager's Guide*	$595
CASE Consortium	Center for Study of Data Processing Washington Univers ity Campus Box 1141 Prince Hall 224 One Brooking Drive St. Louis, MO 63130-4899 (314) 889-4792	*CASE Studies Annotated Software/Systems Bibliography* (over 400 citations in 20 categories) *CASE Studies Consortium MIS Industry Survey*	unknown unknown
CASE Consulting Group, Inc.	11830 S.W. Kerr Parkway Suite 315 Lake Oswego, OR 97035	*An Introduction to CASE: The Best of CASE OUTLOOK* *Annual CASE Directory* *The Executive's Guide to CASE*	$225 $195 $95
CASE Research	155 108th Ave. N.E. Suite 210 Bellevue, WA 98004 Note: CASE Research recently merged with Ernst & Young For more information contact: Ernst & Young's Center for Information Technology Strategy (617) 742-2500	*"The Strategic Impact of CASE" - Volume I Video* *"The Strategic Impact of CASE" - Volume II Video* *Annual CASE Survey 1988* *CASE Bulletins* *CASE in Practice reports* *Product Profiles* *The Second Annual Report on CASE*	$125 $225 $150 $125 $225 $225 $595
German National Research Center For Computer Science (GMD)	Western US Office 1942 University Avenue Berkeley, CA 94704 Publication	*The CASE Products '90* (Macintosh HyperCard-based Public Domain Database) available on Internet, anonymous FTP sumex-aim.stanford.edu:/info-mac/card/case-product-11.hqx	Free
Ovum Ltd	7 Rathbone Street London W1P 1AF England	*Analysis Techniques for CASE: a Detailed Evaluation* *CASE Analyst Workbenches: a Detailed Evaluation* *CASE: the Next Steps* *Real-time CASE: the Integration Battle* *Reverse Engineering: Markets, Methods and Tools*	$995 $995 $995 $995 $1,850
P-Cube Corporation	572 East Lambert Rd Brea, CA 92621 (714) 990-3169	*CASEbase (a PC-based CASE database)*	$495
Foresite Systems	For information contact: Digital Consulting, Inc. 204 Andover Street Andover, MA 01810 (508) 470-3880	*1990 CASE Evaluation Report*	unknown
Software Productivity Group, Inc.	POB 294-MO Shrewbury, MA 01545-0294 (508) 842-4500	*CASE Trends Industry Guide*	$179

Table D-2 CASE Industry- Specific Reports/Directories

Source	Issue	Vol/No	Page No. (pgs)	Title
mputer Decisions	1 Oct 88	v20 n10	p81(3)	*Change control meets CASE*
mputerworld	27 Mar 89	v23 n13	p77(5)	*CASE software products*
C User	1 May 89		p52(4)	*Vendors pack functionality into Case*
ital Review	21 Nov 88	v5 n22	p61(7)	*CASE: tech toolkits for solid software.*
ital Review	24 Jul 89	v6 n29	p37(7)	*Diverse CASE offerings deliver solid applications with speed and finesse*
ital Review	23 Apr 90	v7 n16	p37(5)	*Project management packages offer sophisticated features*
vernment Computer News	7 Aug 89	v8 n16	p56(4)	*CASE tools: timely assistance for PC-based software designers*
E Software	1 May 90	v7 n3	p14(57)	*Tools Fair*
icintosh Buyer's Guide	Fall 1989		p72	*Fall 1989 - Desktop Engineering Directory*
Week	21 Aug 89	v6 n33	p100(1)	*Education clearing the way for implementing CASE*
Week	21 Aug 89	v6 n33	p95(1)	*CASE spurs the re-engineering of users' hearts and minds*
Week	21 Aug 89	v6 n33	p98(1)	*CASE brings order to complex development efforts*
ftware Magazine	1 Oct 90	v10 n12	p41(10)	*The race is on for tools enabled to IBM repository*
ftware Magazine	1 Apr 89	v9 n5	p33(8)	*The CASE way of life; to each his own method*

Table D-3 CASE Industry-Specific Magazine-Based Buyer's Guides

Source	Address/Phone	Title	Price
Data Decisions, Inc.	Cherry Hill, N.J.	*Data Decisions software*	unknown
DATA Sources	Ziff Communications Company One Park Avenue New York, NY 10016 (212) 503-5398	*DATA Sources*	$495
Datapro	McGraw-Hill Info. Sys. Co. Computers & Comm. Info. Group 1805 Underwood Blvd. Delran, NJ 08075	*Datapro directory of microcomputer software* *PC Digest Ratings Report* *Software Digest Ratings Report* *Software Digest Macintosh Ratings Report*	$779 unknown unknown unknown
NTIS	5285 Port Royal Rd. Springfield, VA 22161	*A directory of computer software*	unknown

Table D-4 General Software Industry Reports/Directories

Name	Address/Phone	Conferences
Digital Consulting, Inc.	204 Andover Street Andover, MA 01810 (508) 470-3880	*Accelerating Applications Development (Using RAD, CASE!)* *Analyzing User Requirements* *Capers Jones: Software Measurement & Estimation* *CASE: The Next Generation* *Computer-Aided Software Engineering Symposium* *Data Modeling and CASE* *Evaluating CASE Tools* *IBM's AD/Cycle* *Implementing Software Engineering and CASE*
Extended Intelligence, Inc. (Associated with Dr. Carma McClure)	25 East Washington Street Suite 600 Chicago, IL 60602 (312) 346-7090	*CASE for the 1990s* *Re-Engineering, Repositories, Reusability*
Software Development Concepts (Associated with Dr. Paul Ward)	424 West End Avenue Suite 11E New York, NY 10024 (212) 362-1391	*The CASE/Real Time Curriculum*

Table D-5 Consulting Groups/Conferences

Name	Source	Price
American Programmer	American Programmer 161 West 86th Street New York, NY 10024-3411	$395/year
C/A/S/E Outlook Industry Report	CASE Consulting Group, Inc. 11830 S.W. Kerr Parkway Suite 315 Lake Oswego, OR 97035	$395/year
CASE Strategies	Cutter information Group 1100 Massachusetts Avenue Arlington, MA 02174 (617) 648-8700	$275/year
CASE Trends	Software Productivity Group, Inc. POB 294-MO Shrewbury, MA 01545-0294 (508) 842-4500	$49/year
CASE World News & Digest	Digital Consulting, Inc. 204 Andover Street Andover, MA 01810 (508) 470-3880	Free
Software Engineering **Tools, Techniques, Practice**	Auerback Publishers 210 Sourth Street Boston, MA 02111 (800) 950-1216	$145/year

Table D-6 CASE Industry Newsletters

Name	Sponsor/Contact
CASE World	Digital Consulting, Inc. 204 Andover Street Andover, MA 01810 (508) 470-3880
CASExpo	CASExpo Suite 1210 5203 Leesburg Pike Falls Church, VA 22041-3401 (703) 284-7330
Tri-Ada	Daniel & O'Keefe Associates, Inc Conference Management 75 Union Aveue Sudbury, MA 01776 (1-800-833-7751)
CASELab '90	Research & Technology Institute 301 West Fulton, Suite 718 Grand Rapids, MI 49504 (616) 771-6626

Table D-7 CASE Trade Shows

Name	For information contact
International CASE Users Group	Computer & Engineering Consultants, Ltd. 18620 West Ten Mile Road Southfield, MI 48075-2667 Sponsored by CASE Research
CASE User's Network	Digital Consulting, Inc. 204 Andover Street Andover, MA 01810 (508) 470-3880 Sponsored by Digital Consulting, Inc.

Table D-8 CASE User's Groups

Appendix E Keynote Speech: CASE Implementation Dynamics Through The Technology Life Cycle

CASE Implementation: Dynamics Through The Technology Life Cycle

by

Jonathan A. Morell[1]
Louis G. Tornatzky
James Behm

Industrial Technology Institute

Presented at the
CASE Adoption Workshop
Software Engineering Institute
Carnegie Mellon University
Pittsburgh PA
Nov. 13, 1990

[1] - PO Box 1485, Ann Arbor, MI. 48106 (313) 769-4395 Internet: jam@iti.org

The Challenge of Implementation

When better mousetraps go unused, most people wonder why. We have a contrary view. We assume that many innovations will *not* be used, and when they are, we wonder why. Given the difficulties of moving along the technology life cycle, innovations will often remain "on the shelf". Our curiosity is aroused in the rare instances when everything goes right.

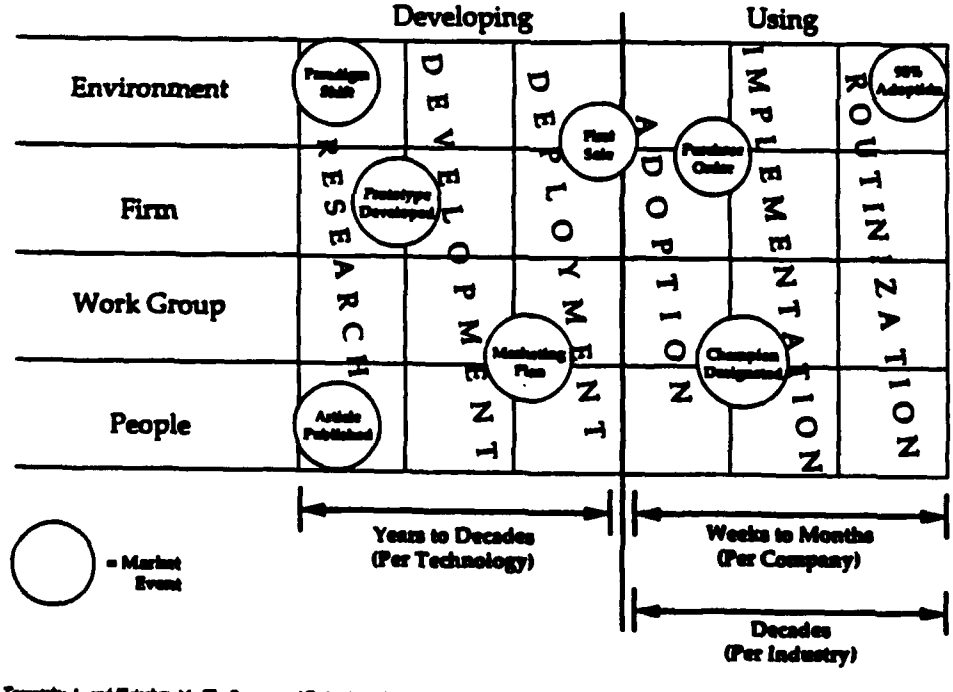
Our view is not overly pessimistic. Innovation *does* occur, and we *can* do things to *make* it occur. We do, however, want to convey a sense of why innovation is difficult, and from there to show how successful innovation can be realized.

We will begin with the long view, looking at innovation in terms of its entire life-cycle. In a second section we will concentrate on specifics of what end-users can do to facilitate useful innovation, and follow with an example relating the dynamics of innovation to the specifics of software engineering tools. Finally, we will conclude with a few words concerning the evaluation of CASE implementation and use.

Views of the Technology Life-Cycle

Two models of technological innovation illustrate different, but complementary views of its difficulties. The first maps critical events against both the stages of development and the parties involved. Figure 1 illustrates this view.

Figure 1:
Processes of Technological Innovation



References: Tornatzky, L. and Fleischer, M. The Processes of Technological Innovation. Lexington, Mass.: Lexington Books

At the simple level, everything moves from left to right. Essentially, this is a modified "stage and phase" view which explains events as innovations move through their life cycle. There are, however, two major deviations from the traditional stage view:

First, there are numerous feedback loops and recursions among the stages.

Second, there is no assumption that development must begin in the research community.

As examples of these complications, consider the following common dynamics in technological innovation:

Early users (for instance those in classic beta site activity), influence late stage development.

Use of an implemented technology may generate new needs which then influence research.

Many new technologies are founded on accepted scientific principles, are motivated by market need, and have no close connection with basic research.

Several important principles are embedded in this diagram.

The first principle is that the organizations involved in each stage tend to be different. Research takes place in universities and federal laboratories, development is carried out by commercializing or R&D firms, while the later stages are carried out by end users. In some cases research, development and adoption may take place in the same firm. In these situations, however, the functional units within the firm are highly distinct. A company's Research division, for instance, tends to be far distant from potential end-using divisions within the same company.

The second principle is that important activities take place at different levels of *social aggregation.* Consider a few examples. At the research end of the continuum, individuals publish articles, while the "scientific environment" commits to one or another paradigm. Or consider activity at the implementation stage. Purchase orders - based on previously developed acquisitions policies - exist mostly at the firm level. Getting purchased equipment used, however, takes place by "product champions", working at the individual and work group levels.

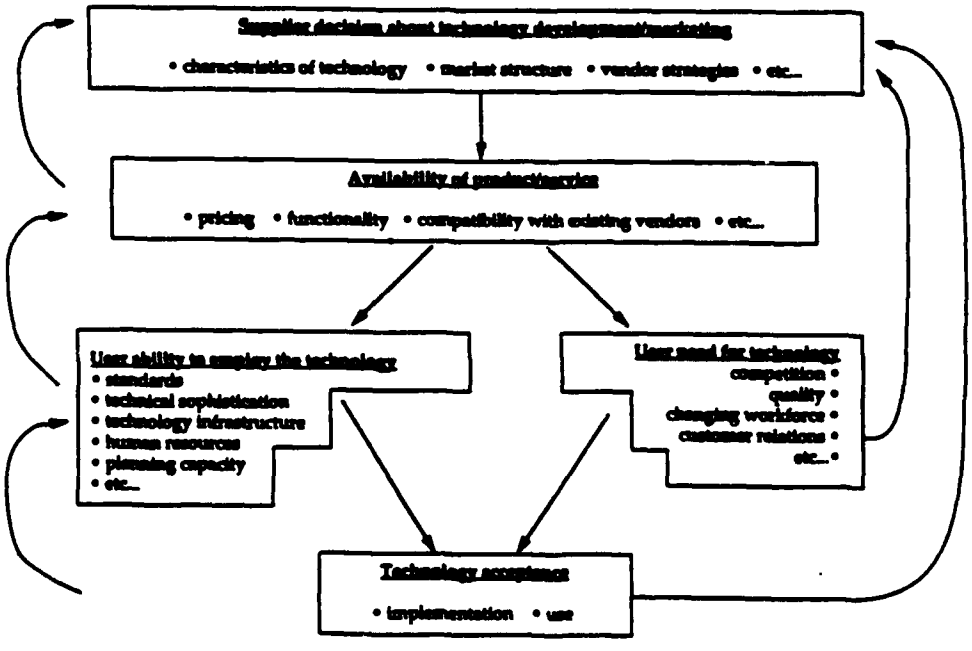
The third principle is that levels of aggregation - individuals, work groups, organizations, and so on - do influence each other, but only in complex ways. An illustration from the world of software engineering can be found in the debate over whether formal systems, because of their complexity, can be made suitable for real-world settings. The dominant view is that such systems are, and will remain, too complex. That world view will not be changed by any given individual opinion or research study. A change will come only if enough people, with enough evidence, holding important enough positions, change their fundamental views. The dynamic of change is as much sociological as scientific.

The fourth principle is that the rate of progress along the life cycle is protracted. Prototype CASE tools, for instance, were available in the mid-1970's. The tools became generally available in the early to mid-1980's, but their use is still limited.

Finally, the model indicates that understanding technological development requires a variety of levels of analysis, and that interactions among those levels can be important. Paradigm shifts do not occur *because* individuals write articles. There is, however, a relationship between the articles people write, and accepted views of a scientific or technological endeavor. Similarly, a company's acquisitions policies are in important ways - but only partially and indirectly - related to the actions of product champions.

The above model conveys a sense of how technological innovation may be understood, but it only alludes to the nature of relationships among relevant parties, and to how the system can be affected by direct action. There are leverage points in the life cycle, particularly in the relationship between technology developers and end-users. A guide for identifying that leverage emerges from our second view of technological development. This view can be found in illustration 2.

Figure 2: Leverage Points for Promoting CASE



The process depicted in the model begins with vendor decisions as to whether a technology should be developed or marketed. Included in this decision are factors such as the characteristics of the technology in question, market structure, and goals concerning marketing incremental improvements versus radical new solutions. A prime example for CASE tool vendors is the question of whether a particular tool will require domain specific interfaces for different users. The more important that differentiation, the greater will be the cost of development and the cost of sales.

These vendor deliberations determine whether a product will be made available. Once available, the product can be characterized by a number of important variables. These include price, functionality, modularity, compatibility with other products, and ease of use.

That unique product then interacts with two multi-faceted elements that determine whether a technology will be accepted by end-users. The first element is end-users' ability to use a product. Determinants of that ability include variables such as the users' technical sophistication, technology infrastructure, planning capacity, human resources, and management capabilities.

Consider for example, a tool to assist people in cataloguing and finding reuse components. Such a tool would be useful only if an organization had a serious commitment to reuse. Would management be willing to encourage reuse by including its deployment in the performance reviews of developers, or by establishing a separate group to maintain reusable components? Do an organization's developers know what how to write a reusable component, and do they have the technical sophistication to piece a system together from such components?

The second multi-faceted element of acceptance is the users' need for the technology in question. Determinants of need include factors such as competitive environment, demands for quality, and the developing organizations relations with its customers. To continue the reuse example, a software company might ponder whether its competitive environment rewards fast development of custom software. If not, the difficulties of implementing a reuse program may not be worthwhile.

Finally, "ability to employ technology", and "need" combine to explain two aspects of technology acceptance - implementation and use. The distinction between implementation and use is important because much purchased technology is unused or under-used.

Also included in our model are numerous feedback loops. As examples, user experience with an existing product may affect vendor decisions about new products; changing user needs may

affect vendor decisions about pricing or functionality; and widespread use within an organization can change both the organization's further need for the technology, and its ability to exploit that technology.

We also believe that by identifying specific factors operating at each transition in the model, possibilities for end-user influence on the process can be realized.

End-user Influence on CASE Technology

An important principle from the end-user point of view is that proximate impact is more powerful than remote influence. Thus, end-users can better control their own implementation strategies than they can influence decisions made by technology vendors. The second principle is that users and vendors are linked in a system, and that comprehensive solutions require a systems perspective. We will now describe how end-users may impact all aspects of the system, with special emphasis on difficulties posed by problems related to an organization's need for technology, and its ability to use technology.

The greatest stretch for end users is an attempt to influence activities going on in the research community. Some privileged users have enough resources, and enough influence, to actually fund CASE related research, or to influence the research agenda of organizations who are doing such research. In most cases, however, influence will be less direct and more diluted. One possibility that comes to mind is membership in various consortia such as MCC[2], CAM-I[3], OSF[4], and CASE users' groups. Another possibility is gaining membership to research based organizations that actively seek advice from the outside. Organizational affiliate status at the Software Engineering Institute, and participation in their resident affiliate program are prime examples.

Less of a stretch, but still not easy, are attempts to influence the behavior of the producers of technology. Participation on standards committees is one prominent route to influence. Standards influence the size of markets, the compatibility of diverse technologies, the likelihood of value added products being developed, and a host of other factors which may sway vendors' decisions about what to produce, and how to configure what they produce.

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[2] - Microelectronics and Computer Technology Corporation

[3] - Computer Aided Manufacturing - International

[4] - Open Software Foundation

A less collective tactic is to serve as a beta site for new products. So doing will set up a direct and close relationship that may well affect the shape of a product or its close cousins. Finally, overlapping memberships in professional associations may open channels of communication and influence.

However effective the above strategies may be, end users are most likely to have the greatest influence on the transition of *existing* products into their *own organizations*. To manage this transition, we propose a perspective which derives from our attempts to introduce new production technologies into manufacturing settings, an approach we call HITOP - High Integration of Technology, Organization, and People.

The essence of this approach is to begin with initial decisions about technology, and closely follow with tightly linked considerations of mutual influences among the chosen technology, its organizational context, and available human resources. Adjustments must be made until the fit is as good as possible.

To manage this process we invoke an inter-disciplinary, and inter-functional implementation management team whose members work concurrently with each other. For CASE tool implementation, team members might include:

members of application development teams,

development managers at the group and project level,

a representative from human resources who can speak to issues of training, reward systems and hiring policies, and

corporate experts who can represent the business case for what new tools should accomplish

The goal of the team is to develop a process for CASE tool implementation that will overcome the very good reasons not to use such tools. After all, CASE tool introduction will:

require changes in organizational and management procedures,
disrupt current operations, and
alter people's comfortable working style.

Consider, for example, the extent of changes that may be required by CASE tool use. Such tools often require the use of particular methodologies. While tool use may not require profound changes in how people develop applications, new methods are very likely to require such changes. What would happen, for instance, if a tool relied on object oriented design, and the adopting organization did not employ such design methodologies? Further, organizational culture might exacerbate the difficulties of needed change. Imposing a particular method in a "cowboy culture" could prove exceedingly problematical.

In developing a CASE implementation, interactions among the HITOP elements must be specifically addressed. Consider some of the elements of each that must come together for a CASE implementation to be successful.

Technology includes

network infrastructure
hardware platforms, and
development life-cycles in which tools are embedded,

Organization includes

coordination among developing units,
accepted mechanisms to track progress and quality,
implementation schedules and timing,
acquisitions policies and procedures,
monitoring of tool use to detect problems and correct difficulties, and
training, incentive, and hiring policies to support tool use.

Human resources include

skills of workforce,
workload, and
availability of qualified new hires.

We do not mean to imply that all considerations are of equal importance - they most certainly are not. But important considerations are ignored at one's peril. CASE implementation teams must make systematic efforts at identifying and considering all important factors in their particular settings. CASE technology is not "self implementing". Making the technology work

involves resolving the conflicts that inevitably arise because of the work and organizational changes that are inherent in using CASE tools.

We also believe that the effort put into managing the introduction of CASE must match the scale of the implementation. It is one thing to test CASE feasibility in a few isolated work groups. Organization or department-wide implementation is quite something else. The critical point is that wide-spread use of CASE can be very costly in terms of time, effort, and money. When such implementation occurs, appropriate care must be taken to design, manage and assess implementation schemes.

Illustrative Examples

At this point it may be useful to trace out some detailed examples of how the three elements of HITOP interact in CASE tool implementation.

Example #1

As an organizational setting, imagine a company with the "cowboy culture" alluded to above. Let us further assume that this organization is staffed with highly competent developers, and has both the resources and commitment to do training. Three types of CASE tools are being considered.

1- a full fledged CASE environment,
2- use of an object oriented language (such as C++), and
3- a good compiler and debugger system.

Notice that these choices have been listed in descending order of the amount of change that each will entail. The full fledged CASE environment will require systematic use of particular methodologies. The object oriented language will require training and a "mind set" change, but it will not necessarily require a total method change. Use of the compiler/debugger system will involve only slight changes in what people are used to doing.

Let us now overlay these technologically driven requirements with organizational and human resource considerations. Organizational concerns mitigate against the full environment - the change would be too drastic. If such an environment were a desirable goal, it should begin with a slow phase-in of a methodology, or at least a set of standard operating procedures. Use of tools which might force a quick changeover should come later. The quality of staff however,

and the availability of training resources, make it possible to choose either the C++ option, the compiler/debugger option, or both. The point is that making an informed choice requires inspection of all three of HITOP's elements - technology, organization, and people.

Example #2

Consider the technical, organizational and human resource issues which may determine the fate of any CASE implementation that requires a common data dictionary. A major technological concern is the size and complexity of legacy systems intended for retrofit with common data elements. As the size of those systems increases, so too will the difficulty of effecting necessary changes.

A second technological issue is the size of new applications to be developed. Again, size and complexity increase implementation effort, and thus decrease the chances of successful implementation. Using common terms within a single development group is relatively simple. Including a few groups is difficult but possible. Enterprise-wide commonality would require a major commitment of time and resources.

A further complicating factor in coordinating diverse teams is work culture. Imagine two teams, one whose members are committed to a uniform approach to software design and internal peer review, and one whose members insist on expressing their individual style. A company filled with the first type of development team will have an easier time implementing common dictionaries than will a company populated by the latter.

Because implementing common data dictionaries is difficult, the effort should only be made if it is judged feasible and necessary from an organizational point of view. Is there enough high level management control to make the change work? Consider how such management control may change with the organizational structure of an Information Systems Department. In some cases those structures are highly centralized, with all developers ultimately reporting to a single Vice President of Information Systems. In other cases, developers are highly decentralized, with different groups reporting to the heads of various business units or divisions. The former case makes it much easier to influence an organizations' overall "application development climate" than the latter.

Another organizational concern is the need to maintain complex and large data dictionaries. Depending on size and complexity, a dedicated maintenance group may be required. Many organizational factors, however, bear on whether such groups can be established.

Finally, the human resource dynamics must be considered. Common data dictionaries are part of development systems which open people's work to scrutiny by others. How will an organization's applications developers respond to such scrutiny, and what will be their reaction to any system that increases that level of openness? Further, the potential sensitivity of these new systems will interact with the existence of innovation champions among the development groups affected. If enough respected technical experts support tool use, successful implementation becomes more likely. If that support is lacking, management desire for tool use may be of little avail.

Evaluation

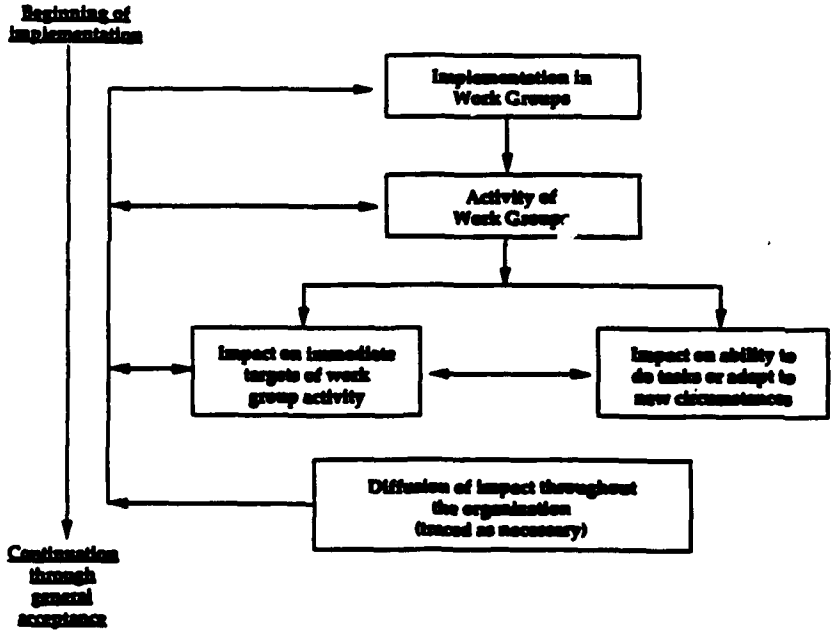
Because CASE use can have such profound consequences for an applications development environment, implementation efforts should be evaluated in order to provide:

guidance for improving implementation,
direction for better exploiting available CASE technology,
information for follow-on efforts, and
a sense of whether (and how) future CASE implementations can be justified.

Because evaluation methodology and measurement of CASE's impact are much discussed elsewhere, we will avoid a discourse on these topics here. What is missing from previous discussions we feel, is an overall intellectual structure that can direct powerful and useful evaluation. Here we hope to convey our view of that structure.

Our approach is adapted from much work we have done studying the impact of office automation, and is presented schematically in figure 3.

Figure 3: CASE Evaluation Scheme



This model contains several desirable features. It begins with the most immediate locus of CASE impact - activities of the work groups that employ the tool. Change at this level is likely to be the most easily observable of all CASE impact. Further, understanding local impact provides a sense of what more diffuse impact may be. Starting with work groups also forces assessors to consider the pace of implementation, and to coordinate data collection with that schedule.

The model implies that CASE technology can have two qualitatively different consequences - it can affect the work that is done, and it can affect *potential* to do *new kinds of work*. We believe this is important because much information technology cannot be justified if its sole consequence is to allow people to do traditional work faster.

A third characteristic of the model is that it forces attention on the diffusion of impact to other parts of the organization. These second order effects might be extremely important. As a simple example, a small productivity increase in many development groups may translate into a pronounced improvement in an organization's ability to respond to its markets.

Finally, the model has a time component. The nature of impact changes from implementation through routinization, and assessment must sample that impact throughout that time.

Summary

The four important elements of this presentation can be characterized with the following statements.

CASE implementation can be planned, managed, and evaluated.

Efforts to promote the use of CASE must be seen in terms of the entire technology life cycle.

Strategies within that life cycle have varying time horizons for success, and different requirements for collective versus individual action. In some cases organizations can solve problems for themselves. For others, inter-organizational cooperation is required.

Within any single organization, CASE implementation hinges on a set of highly dependent interactions among the HITOP elements - technology, organization, and people.

If we have sharpened your sensitivity to these issues, we consider this presentation a success.

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The Software Engineering Institute (SEI) CASE Technology Project sponsored a workshop to address a number of key CASE adoption issues. The workshop was held at the SEI in Pittsburgh, Pennsylvania on November 13-14, 1990. At the workshop, a representative group of SEI affiliates from industry, government, and academia discussed among themselves such adoption topics as CASE benefits, realistic CASE budget estimates, CASE tool fit, CASE adoption roles, and factors in the project success of CASE. The results of these discussions are summarized in this report.

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